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POWER

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Purchaser's Self-Justification

Six months ago a manufacturer said, in effect, "I am convinced there is no lack of business ethics among the big companies with which we do business. All are dependable and would not take advantage of their position as purchaser to the detriment of the vendor."

Now the same man says he was wrong. His change of heart is the result of the purchaser's insistence that contract conditions and guarantees have not been met, while simultaneously refusing to make any concessions to the vendor for failure to provide the working conditions that were stipulated as the basis for the contract guarantees.

Changes have been required in the apparatus—all at vendor's expense. Vendor's suggestions for changes outside his jurisdiction have been adopted without credit to him. Actions of purchaser throughout have been predicated on evident desire of those in charge to justify their own positions at vendor's expense.

This is old stuff, but the marvel is that it should find continuance in places where high ethical standards are fully understood and even preached to others.

EDITORIALS

A Milestone Of Welding

The fall meeting of the American Welding Society, recently held in Boston, will be historic for one thing at least—a report on structural steel welding.

Structural steel may not be a primary concern of the power engineer. He does, however, join steel shapes in setting up machines and equipment. Moreover, the most important element of structural welding is the fillet weld, applied to plates or forms that overlap. Such welds are widely used in constructions that concern the power engineer.

For these two reasons the power engineer has some stake in the report, released at Boston, on the strength of structural welds. This represents five years' labor by experts on the Structural Steel Welding Committee of the American Bureau of Welding. A total of two thousand five hundred specimens were welded by thirty-nine fabricators and tested in twenty-four laboratories. More than $20,000 was contributed for this work. The completed report, of more than two hundred pages, sets up sound standards of unit stress for structural welding. These should be of value in all applications of fillet welds that do not involve changing loads.

Aside from this, the Boston meeting revealed progress in the welding of piping and ships, and in high-speed oxy-acetylene welding. Notable throughout was the spirit of the Boston section, which provided entertainment of unusual quality and did much to insure the success of the convention and of the exhibition that accompanied it.

Centralized Motor Control

About the only objection to centralizing motor control is the higher first cost, but this is offset by several factors. When reduced-voltage starting is employed the cost of control equipment can be materially decreased if it is grouped. Instead of using an auto-transformer for each motor, as when the starting equipment is placed near the machine, a reduced-voltage bus connected to one auto-transformer can serve a number of motors.

The cost of mounting the control equipment at one location is less than at several. Transmitting power to one center of distribution will be less expensive than to a number, and feeder copper can be utilized to better advantage. When power is distributed from several centers about the plant, it is necessary that these be protected by metal inclosures, whereas exposed wiring may be used with centralized control. The control equipment may be installed open in a control room, but if placed at the machine it is usually necessary to protect it with a metal inclosure. These factors help to keep the installation cost fairly comparable with individual control.

Moreover, where the control equipment is concentrated it can be inclosed in a room for protection against dirt, fumes, moisture and high temperatures. In some plants where operating conditions are severe this protection may materially reduce maintenance. Placing the control in one location allows it to be at all times under the supervision of authorized attendants, which is desirable both for safety and for equipment protection.

Automatic control has come into such general use as to reduce the problem of centralizing motor control equipment to economic and engineering considerations. In this first cost is only one of the factors. Greater reliability and reduced maintenance are of greater importance in many installations.

Theory And Practice

There is no stranger sight than a "theorist" and a "practical man" discussing an engineering problem, particularly where mutual respect is not present. Undoubtedly each of these men has something that could help the other. Yet, too often each feels that he alone is right, and each utterly fails to impress the other.

The theorist has learned fundamentals and a certain precise manner of expression. He has not spent much time studying first-hand the ways in which actualities differ from the simplified life of the textbook. He shines most in those branches where practice closely follows the simplified theory. What roiles him is that the practical man (that is, the unschooled practical man) "says things that aren't so," that he uses "heat" and "temperature" interchangeably, that "kilowatts" and "kilowatt-hours" are all the same to him, that he makes no distinction between "power" and torque." And so he distrusts the conclusion, figuring that the conclusion is no more reliable than the reasoning upon which it is based.

In this he often goes too far. The practical man certainly has the advantage of actual experience. He sees actual results. His accounts are worth listening to, even if the explanations need translation into the language of applied science. And the practical man, too, can learn from the theorist if he, likewise, will adopt an open-minded attitude.

A formula is needed that will bring these two together for mutual benefit.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Fig. 1—Big Eddy, one of five hydro plants supplying power to the works, has three 9,400-hp. units

Supplying Power to the World's Largest Nickel Works

Five hydro plants having an aggregate capacity of 62,100 hp., and 16,000 hp. of purchased power is required to supply the mining, smelting, refining and other processes

By W. E. GILLESPIE
Electrical Superintendent
International Nickel Company of Canada, Ltd.

NICKEL is an important metal in several alloys used in modern steam plants, such as in Monel metal, nickel steels and other forms. Sudbury, Ont., about 40 miles north of Georgia Bay, is the source of approximately 90 per cent of the world's nickel. It is in this district, at Copper Cliff, that the International Nickel Company of Canada, Ltd., has the largest nickel mining and smelting operations in the world. These have recently been extended to have a capacity of 8,000 tons of ore per day. In the various processes of mining, hoisting, supplying compressed air, blowing, pumping, transporting, etc., a total connected motor load of approximately 75,000 hp. has to be supplied.

Being in a district where water power is easily available and developed at low cost, and where fuel costs are comparatively high, hydro-electric plants provide the power for all operations. Power is supplied by two systems, the Huronian Power Company, operating on 25 cycles, and by the Lorne Power Company on 60 cycles. These companies are subsidiaries of the International Nickel Company of Canada, Ltd. There are five plants in the two systems, totaling 62,100 hp. These plants are located at an average distance of about 30 miles southwest of Copper Cliff. On the 25-cycle system there are three plants, all on the Spanish River, which flows into Georgian Bay.

Two plants are built at High Falls. No. 1 was constructed in 1905 and No. 2 during 1917. No. 1 has four horizontal-shaft, double-runner, 3,350-hp. turbines operating under an average head of 85 ft. The turbines drive 2,000 kva., unity power factor, 2,400-volt, 3-phase generators, and the power is stepped up to 34,000 volts through six 2,000-kw. banks of water-cooled transformers. Two 200-kw. waterwheel-driven exciter units are supplied by an independent penstock. Either exciter has sufficient capacity for the four alternators, the other being used as a spare.

Plant No. 2 at High Falls has one unit, consisting of a single-runner, vertical-shaft, 7,500-hp. turbine connected to a 5,555-kva., 2,400-volt generator. The head is the same as that at No. 1 plant. The leads of this generator connect to the 2,400-volt busbars in No. 1 plant, and from there the power goes through the six banks of transformers previously mentioned.

During 1919 a storage dam was constructed at the Big Eddy power site, about one mile above High Falls, to regulate the flow of the river. The dam has a maximum height of 146 ft. and creates a reservoir twenty-five miles long. When this dam was built provisions were made to use it as part of a hydro-electric development by providing three 12.5-ft. penstock connections. In the dam near the main channel of the river are four free-discharge Johnson valves for bypassing the water from storage to the forebay of the High Falls plants. The flow before the power house was built and controlled automatically by floats in the forebay that regulate the opening of the Johnson valves. In 1928 Big Eddy plant, Fig. 1, was

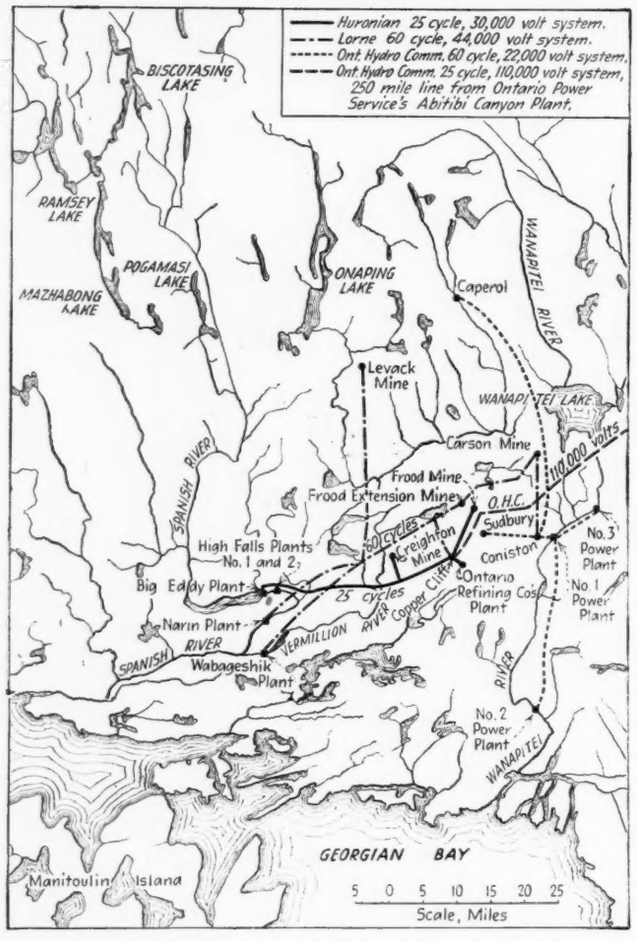


Fig. 2—Map showing the location of the power plants, load centers and their connecting lines

built, and now contains three 9,400-hp., vertical-shaft turbines connected to 8,000-kva., 6,600-volt generators. The head on this plant is 90 ft. Each generator has its own 90-kw., 250-volt, direct-connected exciter. Two 7,000-kva. banks of water-cooled transformers step the power up to 34,000 volts and connect to the transmission system through an outdoor switching station located at the High Falls plants.

The main transmission lines for the 25-cycle system run from these plants to Copper Cliff substations, a distance of thirty miles. It consists of two lines, each having three 4-0 stranded copper conductors arranged in an equilateral triangle with 4-ft. spacing. A branch, four miles long, runs from this line to the Creighton mine, another branch, five miles long, goes to the Frood mine, and the third branch, one mile long, connects to the Ontario Refining Company's plant. The two transmission lines connect through switches to a double bus at the high-tension switching station at Copper Cliff plant. From this bus the 30,000-volt power is distributed to all services, with the exception of that to Creighton mine, which is taken off the transmission line about five miles outside Copper Cliff.

At Copper Cliff the old transformer station contains two 5,000-kva. banks of water-cooled transformers that step down from transmission-line voltage to 2,300 for distribution about the plant. This transformer substation is of the indoor type, and the transformers are in fireproof compartments.

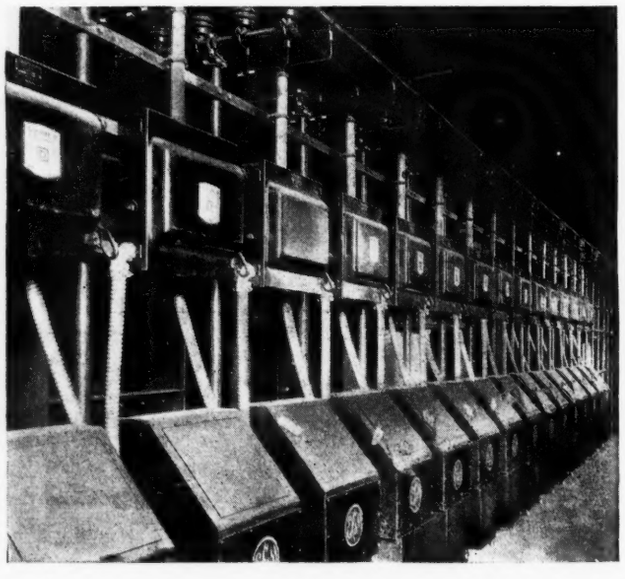
Before the new plant was built all power requirements for the smelter were taken from this substation. At present this station supplies the converter and furnace blowers, the 100-lb. air compressors, the cranes, pumping and lighting loads. It also supplies power to the company's standard-gage electric railway through two 1,000-kw., 600-volt rotary converters.

To take care of the power requirements for the new mill, crushing and screening plant and reverberatory roaster building, a new fireproof substation building centrally located was built in 1929 and connected to the high-tension bus in the old substation. Four 2,000-kva. banks of water-cooled transformers step down to 2,300 volts, and a 3,600-kva. bank of water-cooled transformers steps from 30,000 down to 575 volts. At present two transformers in the 3,600-kva. bank have sufficient capacity when connected open-delta to supply the 575-volt load, so that one transformer in the bank may be considered a spare. When the load increases beyond the capacity of two of the transformers connected open-delta, a fourth transformer will be provided for a spare, or it may even be necessary to install a second bank to meet the demand.

At the Creighton mine the substation is of the indoor type and contains two 2,500-kva. banks of water-cooled transformers for 2,300 volts on the secondary side and two 825-kva. banks of transformers to supply 575-volt power. The latter have been in operation since 1912 without requiring any repairs.

At the Frood mine the substation is part of the hoist and compressor building, and comprises two 5,000-kva. banks of transformers, Fig. 7, for 2,300-volt power and an 825-kva. bank for 575 volts—both banks stepping down from 30,000 volts. A 1,000-kw., 600-volt rotary converter, a duplicate of those at Copper Cliff substation, supplies power to the electric railway connecting the mine with Copper Cliff plant.

On this power system all the equipment, with the exception of the high-tension switching station at High Falls plant, is of the indoor type. All transformers are water-cooled and are located indoors. This type has the advantage of occupying minimum space. On the step-up end of the line the transformers are under the attention of the power house operators. At the supply end of the line all of the substations are parts of air-compressor and blower plants, where there is an operator, and the transformers are under his attention. With the transformers indoors and loaded continuously, no trouble has been experienced from freezing of the cooling water, even when the outside temperature goes to —40 deg. F.



In some of the substations it may appear that more banks of transformers are used than is common practice. This is because the developments at Copper Cliff are the result of many years' growth. Additions to the power supply have been made as required and as the original space in the power houses and substations would permit. Notwithstanding these changes, the power installation is modern and conforms to the best practice. All the processes are continuous, consequently the electrical equipment must be in service except when its driven machine is out for overhauling.

Lorne Power Company was originally a subsidiary of the Mond Nickel Company before its merger with the International Nickel Company. The Lorne Company supplies power to the Levack, Ganson and Frood Extension mines and to the smelter of the Mond Company at Coniston. This system is designed to transmit 3-phase, 60-cycle power at 44,000 volts from two hydro-electric plants, one at Nairn Falls on the Spanish River and the other at Wabageshik on the Vermillion River, a tributary of the Spanish.

The Nairn Falls plant is about seven miles below High Falls and has three vertical-shaft units. Two of the wheels have a rating of 2,250 hp. each and the third 2,500 hp. under an average head of 32 ft. Two of the generators are 1,500-kva. and one is 1,875-kva. rating at unity power factor. The Wabageshik plant, about four miles from Nairn station, contains two horizontal-shaft double-runner turbines of 3,200-hp. and one of 3,000-hp. rating under a 70-ft. head.

Power from each of these two plants is transmitted at 44,000 volts over a single-circuit line. These lines meet about fifteen miles from the power houses, and from this junction one line runs to Levack mine and another goes to Frood Extension and Garson mines and to Coniston smelter. At Garson mine the 44,000-volt power is stepped down to 550 volts through a 1,500-kva. bank of self-cooled transformers. At Coniston smelter, in addition to taking power from the Lorne system, 4,100 hp. at 22,000 volts is purchased from the Ontario Hydro-Electric Power Commission. Power from the former is supplied through a 4,500-kva. bank of transformers at 550 volts. From the latter the 22,000-volt power is transformed to 550 volts through another 4,500-kva. bank of transformers.

On the Spanish River, in addition to the storage provided at Big Eddy dam, several lakes are used for storage purposes, providing an aggregate capacity of 288,000 acre-ft. This is sufficient to generate over 55 million kilowatt-hours in the plants at Nairn, High Falls and Big Eddy. This storage regulates the flow of the river to about 1,800 sec.-ft. The storage capacity may be roughly divided into two systems, the lower and the upper. The former consists of Big Eddy and some of the larger lakes and the latter comprises a number of small lakes, the levels of which are controlled by dams. In operating this storage system effort is made, during the spring, summer and early fall, to hold as much water as possible in the upper system and use that in the lower. This provides for a maximum of storage in the lower reservoirs for run-off during these periods, any excess from the upper reservoirs flowing to the lower ones. Before freezing time in the fall the upper storage system is drained into the lower, so as to lose as little water as possible due to ice on the reservoirs. By this method of handling the stored water a maximum of kilowatt-hours is obtained.

On the 25-cycle system the loading of the plants is controlled from High Falls No. 1 plant. The load is divided between Big Eddy and High Falls so that no water is spilled at the latter. If the water in High Falls forebay approaches the spilling level the operator at Big Eddy plant is notified to reduce the load. On the other hand, when the forebay falls below a specified level at High Falls more load is picked up at the upper plant.

At the Copper Cliff plant there is a 25-cycle auxiliary power supply provided for from the 60-cycle Lorne system by a 750-kva. synchronous frequency-changer set. Normally the 60-cycle machine of the set operates continuously as a motor without load and helps to correct the power factor of the system. The 25-cycle generator is disconnected from the system and operates with its main switch open and without excitation. The set pro-

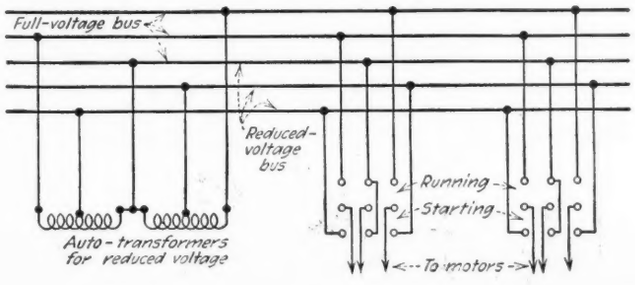
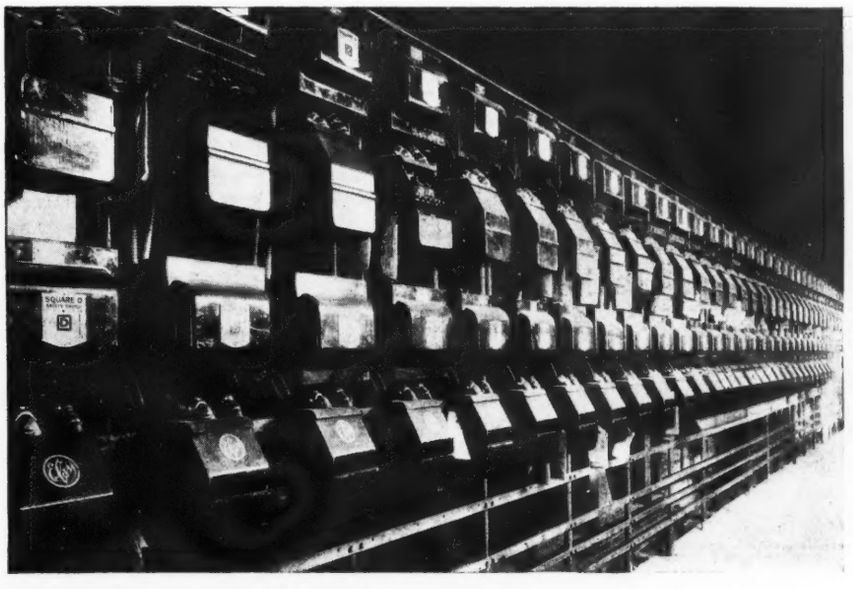


Fig. 4 (Above) — Diagram of connections for reduced-voltage starting of alternating-current motors from the control assembly Fig. 3



Figs. 3 (Left) 5 (Right)—Sections of the control assembly in the concentrator plant. In this assembly, which is 420 ft. long, are the controls for over 400 motors. Fig. 3 shows the control arrangement for reduced-voltage starting equipment and Fig. 5 is part of the full-voltage start controls. Starting and stopping of the motors is by push buttons at the machines

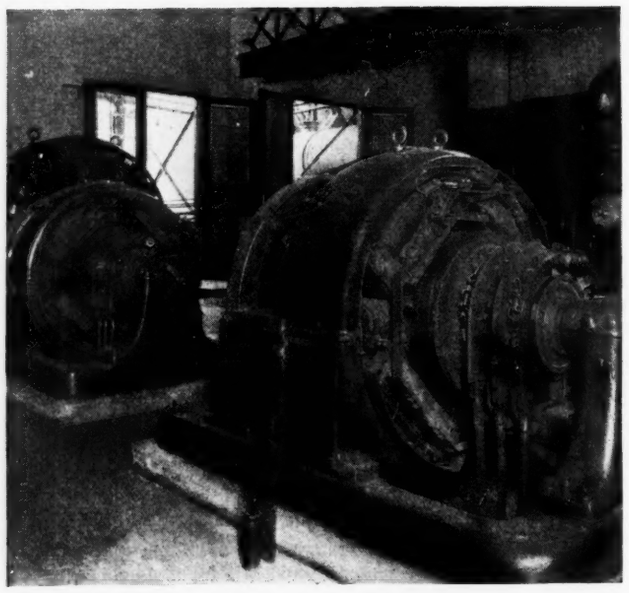


Fig. 6—Two 1,000-kw. 600-volt synchronous converters at the Copper Cliff plant supplying power to electric locomotives on the company's railway system

vides an auxiliary source of power for operating equipment in the concentrator that would be damaged or plugged if the power failed.

A relay holds the generator's field circuit open as long as the normal 25-cycle power supply to the concentrator is maintained. If this power source fails the relay automatically closes the generator's field circuit and the voltage rises to 2,300 on the auxiliary bus, and is maintained at that value by an automatic regulator. An automatic transfer switch disconnects the bus that normally supplies the tailings-pump motors from the main 25-cycle system and connects it to the auxiliary bus. This makes it possible to start these pumps immediately from the auxiliary system.

Power is also supplied from the generator to a bank of three 175-kva. transformers that step down to 550 volts. These transformers provide a power supply to motors operating on this voltage that must be kept in operation to prevent damage to or plugging of equipment.

Emergency lighting is supplied from a 25-kva. single-phase transformer, and the lights come on automatically in case of power failure on the main supply.

When normal power returns the system changes over to it automatically, without the motors that are running on the auxiliary power having time to stop. This auxiliary power supply is intended to provide for a total power failure of the main source only and does not function on sectional failures caused by overloads, etc.

The metal-refining converters are turned by 65-hp., 230-volt, direct-current series motors. Power for these motors is supplied by two 300-hp. flywheel motor-generator sets. Wound-rotor alternating-current motors drive the direct-current generators, and are arranged for heavy-duty starting. The flywheels have sufficient weight so that in case of an alternating-current power failure the motor-generators will continue running and supply power to turn all the converters to a safe position.

The direct-current generators are shunt wound and have an automatic voltage regulator. This regulator keeps the voltage at 230 while the speed is dropping to approximately 80 per cent of normal value. During this time all the converters will have turned to a safe position.

On the converters the motor control is so arranged that if either power or air pressure fails the converters will automatically be turned to a safe position where the tuyères will be clear of metal. Should a converter be turning to the blow position at the time of air of power failure, the operator automatically loses control and the converter stops and turns back to a safe position.

The general plan of power distribution about the mill is to run feeders in conduit to distribution centers in the different departments. At these centers the feeders connect to copper-tube buses at the top of open pipe-work structure, Fig. 3, on which the switching and starting equipment is mounted for the individual motors. On motors started by connecting directly to the line the ordinary three-bus arrangement is used. Each motor is connected to the bus through a magnet starting switch and a safety-type knife switch. A push button is located at the motor for starting and stopping.

For reduced voltage starting a five-bus arrangement is used with two auto-transformers connected in open-delta and to three of the busbars, as in Fig. 4. The center bus acts as a common to both the reduced- and the full-voltage systems. For each reduced-voltage-start

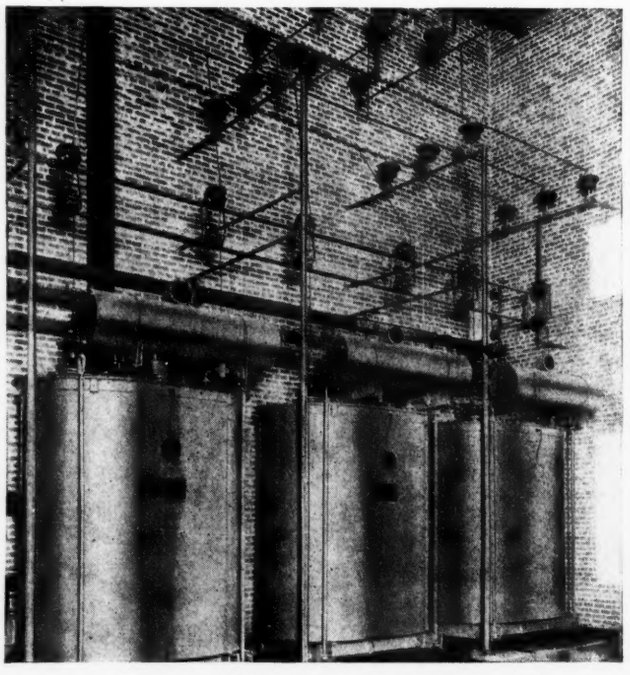


Fig. 7—Bank of three 1,665-kva., 30,000- to 2,300-volt oil-insulated self-cooled transformers supplying power to hoists and compressor motors at Frood mine

squirrel-cage motor there is a safety-type knife switch and a two-position automatic starting switch. Starting and stopping of the motors are from push buttons at the machines. For each wound-rotor motor a safety-type disconnect switch and a magnetic-type primary switch are located in the control room. The push button for the primary switch and the drum-type control for the rotor are at the motor.

In the concentrator plant the controls for over 400 motors are arranged in one room. Figs. 3 and 5 show part of this equipment, the entire assembly extending for over 400 ft. The room is kept locked, no one but the electrical chief for the mill having access to it. If a motor or its driven machine is to be worked on the mechanic to do the work comes to the electrical chief, signs a book and records the motor circuit to be made dead. The chief electrician kills the circuit and tags it. When the workman returns to the machine he tests the

circuit by trying to start the motor from the push button to make sure that the line is dead. When the work is completed and the workman wants the line made alive he again signs the book and records the circuit to be energized, after which the chief electrician removes the tag and closes the switch. This system has worked very satisfactorily and has eliminated tampering with the electrical equipment by unauthorized persons.

Both the 550- and the 2,300-volt systems are kept insulated. Ground detectors are used on both systems, and when a ground occurs it is cleared at the first opportunity. One of the most serious sources of trouble on the motors used to be from worn bearings allowing the rotor to rub on the stator and burn out the windings. All motors in the plants are now equipped with antifriction bearings, and they have resulted in a very large reduction in winding failures. The lubrication of the motors and their temperatures are closely watched, and the first sign of danger is investigated and the causes removed.

By doing this and keeping the machines clear of grounds serious trouble has been reduced to a negligible quantity. The plant being a continuous process, little opportunity is afforded to do regular maintenance work. When a process machine is shut down for repairs or for other reasons the electrical equipment is thoroughly inspected, cleaned and put in good condition.

Large quantities of air are required by the processes and in the different operations that are supplied by compressors and blowers. All of these are suitable for synchronous motor drive and have made it possible to select a combination of induction and synchronous motors that gives a load power factor of nearly unity. Even at the mines the synchronous motor drives on compressors compensate for the lagging power factor of the hoist induction motors and other induction motors about the works and maintain the power factor near unity. It is of interest that a total of about 25,000 hp. of motors is required to drive the compressors and blowers to supply air to the mining, concentrating and smelting processes.

A new mill is now under construction and extensions are being made the power requirements for which are beyond the capacity of the company's hydro systems, so a new source of power had to be found. In the Sudbury district most of the rivers are short and have small drainage areas and in general are not suitable to supply large quantities of power at high load factors, about 70 per cent, as required by the plant. On this account and because of the possibilities of a large future growth in the load it was desirable to tap a power source that would insure a practically unlimited supply. To this end a contract has been made with the Ontario Hydro-Electric Power Commission for 16,000 hp., which is to be delivered over a 110,000-volt transmission line connecting with a 275,000-hp. plant of the Ontario Power Service Corporation on the Abitibi River, 250 mi. northeast of Sudbury.

The 110,000-volt power will be stepped down to 30,000 volts through a 15,000-kva. bank of self-cooled transformers and will connect into the present 30,000-volt system at the mill's substation. The transformers and the switching equipment for the new power source will be out of doors.

This power will serve the base load at the mill, the present sources supplying the remainder of the load and acting as stand-by in case of line failure. Because of the storage available above the plants on the Spanish River they are well suited to supply the peak and stand-by service.

These works are so far away from the sources of good coal in Canada that fuel must be imported from the United States; consequently coal cost at the mill is comparatively high. All uses for fuel have been eliminated except for metallurgical processes and for heating the buildings at the mines. On the railways that connect the mines with the plants steam locomotives have been replaced with electrical types. These get their power from the hydro-electric plants and have reduced the haulage costs 50 per cent.

The plant is located in a cold climate and the heating season is long. Heating steam for the plant and offices and other purposes is provided by waste-heat boilers on two of the reverberatory furnaces. These boilers are used in the heating season only, as steam is not required in any of the processes.

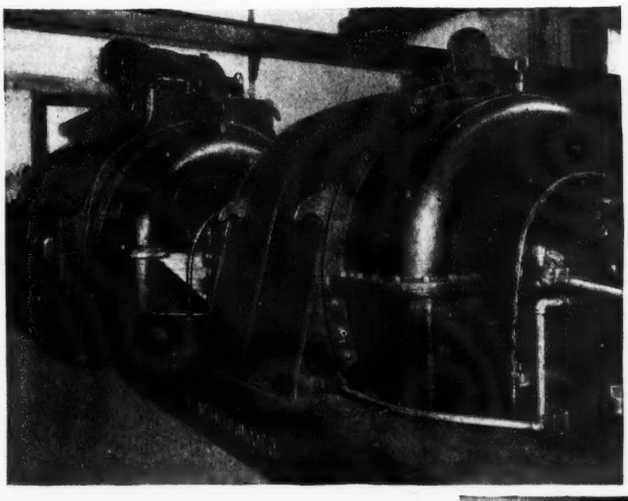


Fig. 8—Turbine-blower having a capacity of 42,000 cu. ft. per minute and 13 lb. gage pressure, driven by a 2,800-hp., 1,500-r.p.m. 2,300-volt synchronous motor

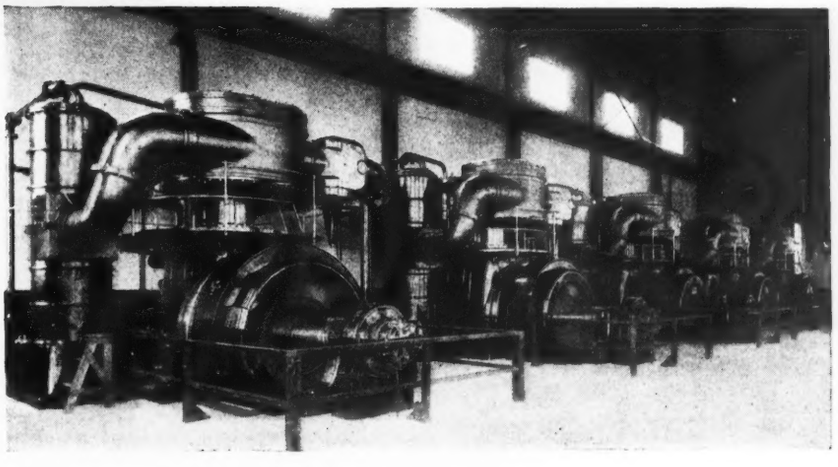
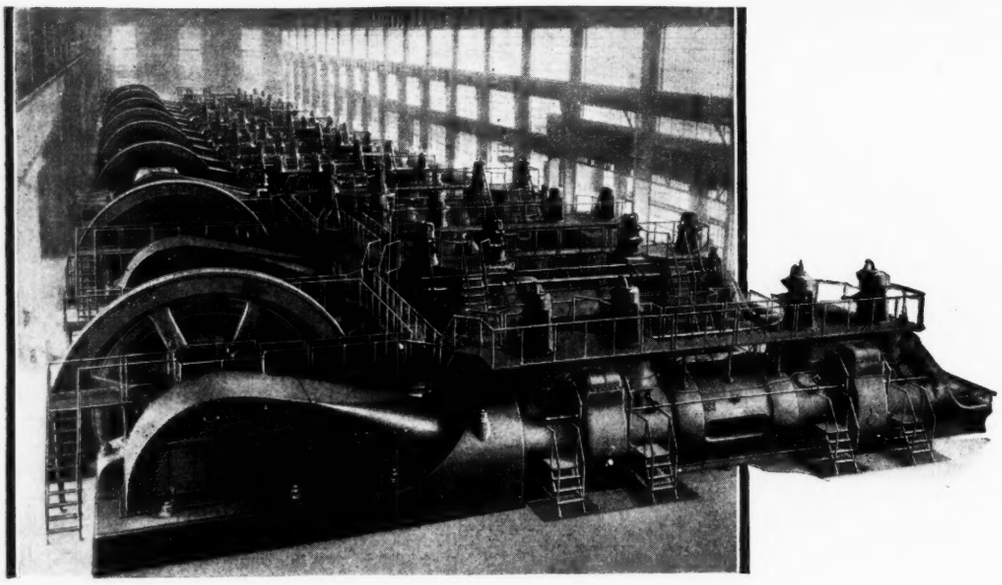


Fig. 9—Five vertical 5,000-cu.ft. per minute air compressors, each driven by a 1,050-hp. synchronous motor at Frood mine



SETTING VALVES OF LARGE GAS ENGINES

By R. C. LANEY

Large gas engines appear to the casual observer to be quite complicated. As a matter of fact they are in many respects more simple than the motor in today's automobile

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THE PARTICULAR engines to be considered in this discussion are the horizontal twin tandem double-acting type designed to use blast-furnace gas as fuel. They have been built in sizes ranging from 36-in. bore with 48-in. stroke to 60-in. bore with 64-in. stroke. The 48-in. x 60-in. engine appears from experience to be the better balanced and gives better services for either generator or blowing-tub drives.

Regardless of size, these engines have a compression of from 160 to 170 lb. per square inch, and with a gas averaging 90 B.t.u. per cubic foot give an initial pressure of approximately 325 lb. per square inch without showing signs of distress.

The cylinder-head clearance averages $\frac{1}{2}$-in., although there are two instances where a 2-in. cylinder-head clearance is used without an appreciable drop in compression. The total piston clearance ranges from $\frac{3}{16}$ to $\frac{1}{4}$ in. The piston-ring gap is usually established at 0.002 to 0.004-in. per inch of cylinder diameter. The groove clearance ranges from 0.004 to 0.006 in. for a standard $\frac{3}{4}$-in. piston ring.

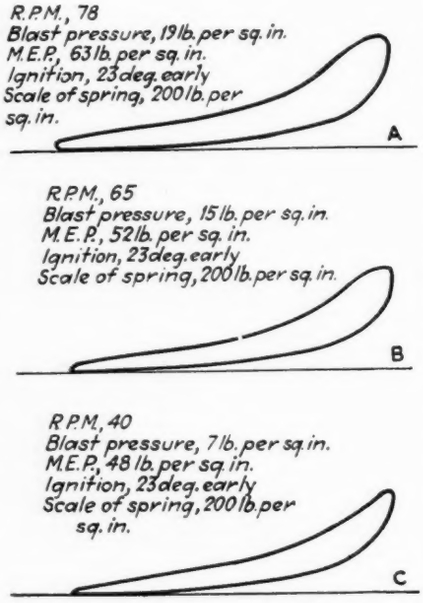
R.P.M., 78
Blast pressure, 19 lb. per sq. in.
M.E.P., 63 lb. per sq. in.
Ignition, 23 deg. early
Scale of spring, 200 lb. per sq. in.
A
R.P.M., 65
Blast pressure, 15 lb. per sq. in.
M.E.P., 52 lb. per sq. in.
Ignition, 23 deg. early
Scale of spring, 200 lb. per sq. in.
B
R.P.M., 40
Blast pressure, 7 lb. per sq. in.
M.E.P., 48 lb. per sq. in.
Ignition, 23 deg. early
Scale of spring, 200 lb. per sq. in.
C

Fig. 1—Indicator Cards taken on 48x60x82-inch Blowing Engine

The inlet and exhaust valves are of the poppet type, with water-cooling on the exhaust valve and stem. They are operated from eccentrics on a layshaft running along the side of the engine at right angles to the crankshaft. The inlet valve opening varies from $2\frac{3}{4}$ to 4 in., depending on the size of the engine, and the exhaust valve opening varies from $2\frac{3}{4}$ to 4 in. The gas valve is a cylindrical double-seated valve and sits directly above the inlet valve surrounding the stem as shown in Fig. 3. The lift of this valve varies from $\frac{1}{2}$ to $1\frac{3}{4}$ in. The valve makes its seat in the air cage. In this manner the air and gas are thoroughly mixed in the right proportions while they are being drawn through the inlet valve. The older type of air cage was not adjustable and the amount of air was controlled by a butter-fly valve in the mixing chamber at the combustion-air connection. The old theory

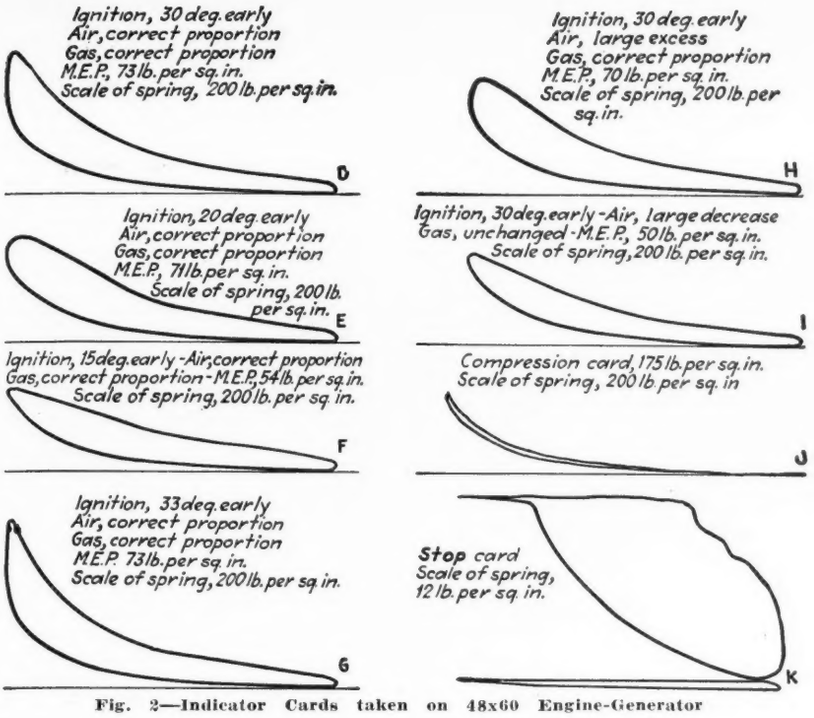
Ignition, 30 deg. early
Air, correct proportion
Gas, correct proportion
M.E.P. 73 lb. per sq. in.
Scale of spring, 200 lb. per sq. in.
D
Ignition, 30 deg. early
Air, large excess
Gas, correct proportion
M.E.P., 70 lb. per sq. in.
Scale of spring, 200 lb. per sq. in.
H
Ignition, 20 deg. early
Air, correct proportion
Gas, correct proportion
M.E.P., 71 lb. per sq. in.
Scale of spring, 200 lb. per sq. in.
E
Ignition, 30 deg. early - Air, large decrease
Gas, unchanged - M.E.P., 50 lb. per sq. in.
Scale of spring, 200 lb. per sq. in.
I
Ignition, 15 deg. early - Air, correct proportion
Gas, correct proportion - M.E.P., 54 lb. per sq. in.
Scale of spring, 200 lb. per sq. in.
F
Compression card, 175 lb. per sq. in.
Scale of spring, 200 lb. per sq. in
J
Ignition, 33 deg. early
Air, correct proportion
Gas, correct proportion
M.E.P. 73 lb. per sq. in.
Scale of spring, 200 lb. per sq. in.
G
Stop card
Scale of spring,
12 lb. per sq. in.
K

Fig. 2—Indicator Cards taken on 48x60 Engine-Generator

was that the air and gas entered the cylinder in layers. For this reason the inlet valve assembly was sometimes called a stratification valve. This theory has long since been dispensed with.

Governor control of the gas valve lift and the amount of opening in the air cage, when properly adjusted, assure a good mixture at various loads and speeds, the mixture being about 61 per cent gas and 39 per cent air. This is usually considered a perfect mixture for blast-furnace gas containing from 22 to 25 per cent carbon monoxide. It has been estimated that such a mixture develops about 53.3 B.t.u. per cubic foot. Control of the mixture is obtained through a regulator layshaft operated by an oil relay, which, in turn, is operated by a spring-loaded fly-weight governor. When the interlocking rods and eccentrics between the regulator and the gas valve and air cage are properly adjusted the governor will increase or decrease the proportion of the mixture by increasing or decreasing the lift of the gas valve and the openings in the air cage.

There is a fairly high velocity of the air and gas through the gas and inlet valves. If the gas is not clean the dirt collects on the gas valve due to the change in velocity at this point and decreases the size of the opening. When this occurs the proportion of gas to air is decreased and the governor no longer gives smooth operation. This condition is remedied by a hand adjustment on the air cage whereby the amount of air can be decreased or increased at will. After about one year of operation the gas valve becomes filled with dirt to such an extent that a full proportion of gas cannot be obtained through the valve, and it must be taken out and cleaned. Poor regulation on engines driving a generator is readily noticed by a swing on the indicating wattmeter of the generator. In the case of engines driving a blowing-tub faulty regulation is first brought to notice by the irregular swing of the tachometer.

The writer recently had an experience with a new blowing engine using the latest design of variable-speed governor. The governor and individual mixtures were adjusted by an indicator to balance the mixtures and ignition, with the engine carrying 21 lb. blast in pressure at 80 r.p.m., the maximum speed. By means of a motor drive on the governor's variable-speed adjustment the speed was set at 40 r.p.m. as rapidly as possible and the pressure dropped to 7 lb. per square inch. The tachometer recording chart showed a steady speed drop from 80 r.p.m. to 40 r.p.m. and then practically a straight line at the 40 r.p.m. position until the speed was again changed. This showed that the governor was increasing both the gas and combustion air in perfect proportion to maintain a steady speed after such a radical change in revolutions per minute. The indicator diagrams in Fig. 1 were taken from that engine.

Until recently large gas engines used low-tension ignition, with a hammer-type make-and-break igniter. An induction coil was placed in series with the igniters. Current for this type of ignition was furnished by a small motor-generator set or by a storage battery floating on a low-voltage direct-current system. The induction coil took the current at 110 volts and increased it to perhaps 400 or 500 volts at the instant the igniter hammer opened. This type of ignition gave satisfactory results except that igniter maintenance was high. The hammers stuck quite frequently and the engine missed fire, causing a swing in load or speed and sometimes a backfire. A constant watch had to be maintained to keep the igniters in operation. Engines built in sizes up to 44-in. cylinder diameter used two igniters per cylinder. The number was increased to four igniters per cylinder on a 60 x 64-in. engine.

Today magnetos are in service supplying satisfactory ignition to some of the largest gas engines built in this country. They have been in operation for a year in one of the steel mills of the Middle West and for about two years in one of the Eastern steel mills. The results have been such that they were specified as standard equipment on six 48 x 60 x 82-in. blowers and one 60 x 64-in. generator unit now being installed or operating in a Mid-Western steel mill.

The magnetos are of the two-spark type, with a double distributor. One magneto will force a spark across the gap of two plugs simultaneously, and when properly timed will operate four cylinders with two sparkplugs in each cylinder. Used in connection with a specially designed coil built by the magneto manufacturer, these magnetos will supply about 18,000 volts across the sparkplug gap. The plugs are $\frac{3}{4}$-in. Whitworth pipe size, with a four-point gap instead of the usual one point. The magnetos are designed with individual adjustment on the interrupter segments, thereby permitting each cylinder to be adjusted for ignition separately.

When horizontal tandem double-acting engines of the larger sizes were first built little was known about the opening and closing positions or maximum lifts of valves. To obtain these positions in the proper relation some manufacturers used a system of cams and levers for opening and closing the valves. Other manufacturers used eccentrics and rods in connection with straight and curved levers which were arranged to produce a

multiplying action. The latter system was the more prevalent and is used extensively today.

Valve timing formerly was particular and laborious work. The curved, or multiplying, levers used for opening the valves were machined to an approximate shape at the factory and had to be filed and ground when the valves were being timed in order to obtain the proper lift and still have the valve close when it should. It was a process of elimination by trial until a setting was obtained which would work satisfactorily. By this method a system was eventually worked out whereby the levers could be properly machined at the factory. The positions of opening, of closing and of maximum lift worked out by the above method years ago are still adhered to closely.

Now when setting valves the levers and eccentric rods are first adjusted to give maximum lift on all the valves. The gears driving the valve mechanism are then meshed

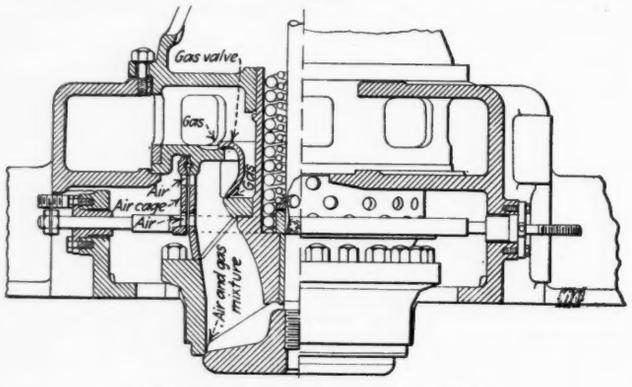

Fig. 3—Inlet Gas Valve Assembly

in with one inlet valve just starting to open and the flywheel is set a number of degrees early, usually 20. The other inlet valves and the exhaust valves, as well as the gas valves, automatically come into time, since they are driven from keyed eccentrics all of which are operated from the same layshaft. It has been found that 5 deg. either way of this setting is hardly noticeable on an indicator diagram. Levers and pins must have considerable wear before the operation of the engine is affected. This setting is for a single-tandem engine. For twin-tandem engines there is a layshaft for each side of the engine and the operation is repeated for the second tandem.

Adjusting a gas engine by means of the indicator is an interesting job. It requires ability to interpret the diagram. The type of load the engine is pulling has considerable bearing on the shape of the diagram obtained. Constant or variable speed and variable load are other determining factors.

The diagrams reproduced in Fig. 1 are for a blowing engine having a variable load and speed and working under normal operating conditions. On the other hand, the diagram *D* in Fig. 2 is a perfect one for an engine-generator unit under normal operating conditions and would appear to be the kind of diagram one should strive to obtain under any kind of speed or load conditions. Diagram *A* of the blowing-engine group is left low on air and gas to allow the governor to catch any surge or sudden increase in pressure on the blast main. Should such a condition occur the engine would not stall, and a diagram similar to the first diagram in the engine-generator group, Fig. 2, would be obtained. As the load decreases and the speed drops in proportion the mean effective pressure drops also. The next two diagrams in Fig. 1 show this condition. One might think that they are poor, but a diagram of this shape must be obtained to maintain the slower speed and lower blast pressure. The adjustment of the air cage is set so that the air supply decreases more slowly than the gas. An analysis of the exhaust gases would show about 1, 2 and 4 per cent oxygen for the three cords, with no carbon monoxide. In other words, the combustion of the gas would be complete, with a reserve maintained on the air to burn an increase in gas should a surge in blast pressure demand it.

The indicator diagrams in Fig. 2 were taken from an engine-generator unit and show the result of good and bad adjustment on an engine of constant speed and variable load. *D* is as nearly perfect as can be expected, but *E* and *F* show the result of late ignition. These diagrams are thicker at the exhaust end of the expansion curves. Although the combustion may be complete, unless the ignition is too late the cylinder from which they were taken was not doing the work it should. The fourth diagram *G* shows early ignition. With this condition the cranks work heavy and pound. The entire engine seems to labor without producing any extra power. An increase in power, if any, is gained at a sacrifice in the life of the engine.

Diagram *H* is intended to show an excess of air, although it is sometimes difficult to distinguish it from a diagram having low ignition. An exhaust-gas analysis would show that combustion is complete with an excess of air. There would be a loss of power, however, should the engine be set for maximum load. If a light load was being carried at the same speed this would be the ideal diagram to obtain. The lack of air or a rich mixture is shown by diagram *I*. There is incomplete combustion here as well as a loss of power. Excellent compression is shown in *J*, taken with a 200-lb. spring, as were all the others, the compression was 175 lb. per square inch.

A "stop" diagram taken with a 12-lb. spring is shown at *K* which gives a good idea of the suction and exhaust strikes. It indicates a good valve setting. To be ideal the end of the exhaust line should drop to the atmospheric line before the piston reverses motion.

▼

Repairing a Small Needle Valve

IN REPAIRING needle valves of small capacity, such as are used for the handling of refrigerants, some knowledge of the methods used in their manufacture may be of help.

Valves of this type usually have the seat cast as one piece, with the brass body, and thus it is not renewable. When manufacturing these valves the usual procedure is to line up the body on the baseplate of a drill press and to drill, through the center of the seat, a hole of the size corresponding to the rated capacity of the valve. The seat is then formed by countersinking the drilled hole with a 60-deg. self-centering tool.

After this operation the body is left blocked in the same position on the baseplate of the drill press, and the needle which is to be used with this particular valve is placed in the drill chuck and the needle and seat are ground together, using a mixture of emery dust and oil. The valves are then assembled and inspected.

When one is found that leaks it is dismantled and the body lined up again on the baseplate of a drill press, as before, and then reseated very lightly with the centering tool revolving in the drill chuck, so as to remove any scratches. After this the needle is again placed in the drill chuck and the seat and needle reground as before. When worn slightly these valves can be reseated in the machine shop in the same manner.

Industrial Boiler Plant Design

By H. BLEIBTREU
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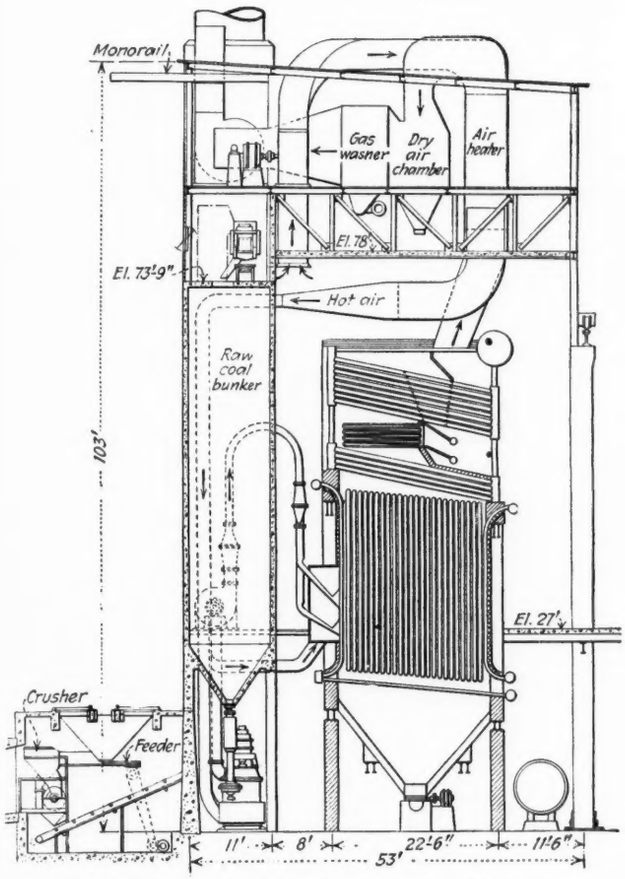


Fig. 1—Typical boiler house for large industrial or public utility plant

The author is a designer of power installations with long experience both in this country and Germany. A five-month tour of Europe this year observing recent Continental practices has given him an excellent basis for comparison. His cost figures and typical designs tending to reduce overhead should prove of interest

UNDER average conditions the production cost of 1,000 lb. of steam ranges from $0.30 to $0.50. Of this amount, $0.15 to $0.30 is for fuel, while the capital costs vary with the load factor, between $0.08 and $0.20. With cheap coal and low load factors the capital costs may be equal to or even greater than the fuel costs. With the high efficiencies of modern boiler plants the fuel costs could be reduced only slightly. On the other hand, there are a number of means for further decreases in the capital costs. The trend of development in the power plant field points to an ever-increasing importance of low investment costs.

Table I is an analysis of costs of modern industrial boiler plants. The two largest items are the building, with coal bunkers, and the boilers, with superheaters and soot blowers. The total cost of the boiler plant varies between $120 and $200 per 10 sq.ft. of heating surface, with $175 as a fair average.

Savings in the cost of boiler plants can be effected by standardization of boilers and boiler house equipment, by careful design of the general layout and proper allocation and dimensioning of coal-handling facilities and bunker space, and by careful planning by both the designing and the contracting engineer.

American practice has proved that the conventional boiler types, with certain changes, lend themselves readily to high pressure and radiant-heat transmission. Therefore, economical possibilities must be looked for more on the side of improved manufacturing methods than, as in Europe, in the realm of new types. By this the writer does not want to imply that certain European features may not find a field in America. It will be well, however, to wait until one or two definite types have been crystalized from the rather conflicting views of European boiler manufacturers.

Economical Layout

In laying out a boiler house two general rules should be observed. First, the cost of the building above foundations being mainly determined by the volume, the cubical contents of the building should be as small as possible without impairing the accessibility of the equipment. Experience shows that building wide rather than high, with economizer and air heater alongside of, instead of above, the boiler, is more economical, both from the standpoint of building volume and weight of structural steel. This rule does not hold true for the boiler itself, as a narrow boiler with the boiler and the combustion chamber as a straight block, may be most economical to build.

Second, modern coal-handling equipment is of such reliability that the size of indoor coal bunkers could be reduced. To increase the safety factor against interruptions of coal supply to the boiler it is usually more economical to double the capacity of the coal-handling machinery rather than the bunker volume.

Table II gives data on the building volume, the amount of structural steel and the prices of four modern boiler houses, each of which represents a typical set-up. Although the figures compare favorably with average practice, it will be shown by the following designs that further savings are possible.

Fig. 1 is a design for the boiler house of a large industrial power plant. The concrete silos for the raw coal stand in front of the 16,000-sq.ft. boilers in such a way that the boiler fronts are fully exposed to daylight,

and so that the tubes can be easily removed. The silos, with windows between them, form the front wall of the building. They are self-cleaning, which is important with fine coal, and as they extend down to the mills large quantities of coal can be stored. The silos are of monolithic structure, and carry the stacks, which may be of steel, brick or concrete. Heavy steel columns can be dispensed with. The air heater and the dry and wet gas washers are placed on the roof, separated from the boiler room by a solid ceiling. Thus dust and sludge will be kept away from the boiler room, so that a partitioning wall separating the engine room may be eliminated. The upper story is incased by light sheet metal with wide sliding doors, which provide for good ventilation and also can be used for the removal of the fans by monorails.

With a boiler house width of 53 ft. and a height of 103 ft., the volume, including the bunkers, is only 120 cu.ft. per 10 sq.ft. of boiler heating surface. Assuming the same plant with the conventional parabolic overhead bunker, the space requirements per square feet of boiler surface would be about 150 cu.ft., and the construction cost about $27. Of this amount, $15 is attributable to the house itself and about $12 to the bunker.

With the design shown, 1 cu.ft. of boiler house volume with bunkers and upper story can be built for about $0.18, corresponding to a cost of $21.60 per 10 sq.ft. of boiler surface. This represents a saving of about 20 per cent over the conventional design. The arrangement shown in Fig. 1 will lend itself to public utility plants with single or double rows of boilers, as it will eliminate the objectionably heavy substructure for the stacks.

An economical arrangement lending itself to medium-sized boiler units of the Stirling type is shown in Fig 2. With 55 ft. width and 68 ft. height, the boiler house, with economizers and air heaters, contains 7,500-sq.ft. boilers. The house volume with the coal bunker included reduces to 140 cu.ft. per 10 sq.ft. of boiler heating surface. Owing to the inverted position of the boilers, with their fronts toward the turbine room and their firing from the rear, all essential parts are accessible and exposed to natural light. The space above the larry car lends itself to dust catchers of the dry or Cottrell type. The columns for economizers and air heater also carry the stack and induced-draft fans. The placing of marine-type fans in the open on top of the roof has been found

TABLE I—ANALYSIS OF COSTS FOR INDUSTRIAL BOILER PLANT

	Dollars Per 10 Sq.Ft. of Boiler Surface
Foundations for building equipment	8 to 12
Building and fuel bunkers	20 to 40
Boilers, superheaters, soot blowers (erected) [1]	20 to 35
Economizer (erected) [1]	10 to 20
Air heaters (erected)	10 to 15
Settings	6 to 10
Coal firing and forced-draft equipment [2]	12 to 18
Coal handling equipment	5 to 7
Ash handling equipment	4 to 5
Breeching and chimney	7 to 10
Feed pumps	2 to 3
Piping	10 to 15
Water treating plant	6 to 9
Motors, wiring and lighting	6 to 8
Combustion control	1 to 3

[1] Boiler pressures of 250 lb. and less.

[2] Including unit mills in case of powdered coal.

TABLE II—VOLUME, STRUCTURAL STEEL WEIGHTS, AND COST OF BOILER HOUSES WITH COAL BUNKERS

	Cu.Ft. Building Space per 10 Sq.Ft. of Boiler Surface	Structural Steel Lb. Per 10 Sq.Ft. of Boiler Surface	Cost of Building and Coal Bunkers Above Foundation Per Cu.Ft. Building Space	Per 10 Sq.Ft. Boiler Surface
1—Two 5,120 sq.ft. straight-tube boilers—3 unit mills—overhead bunkers	118	197	$0.22	$26.50
2—Four 6,000 sq.ft. 4-drum Stirling-type boilers—traveling grate stokers—overhead bunkers	158	280	0.25	39.30
3—Six 8,140 sq.ft. 3-drum Stirling-type boilers—traveling grate stokers and blast furnace gas—overhead bunkers	150	270	0.16	23.55
4—Six 9,120 sq.ft. boilers—economizers—8 unit mills—1 traveling grate stoker — overhead bunkers	193	269	0.17	31.95

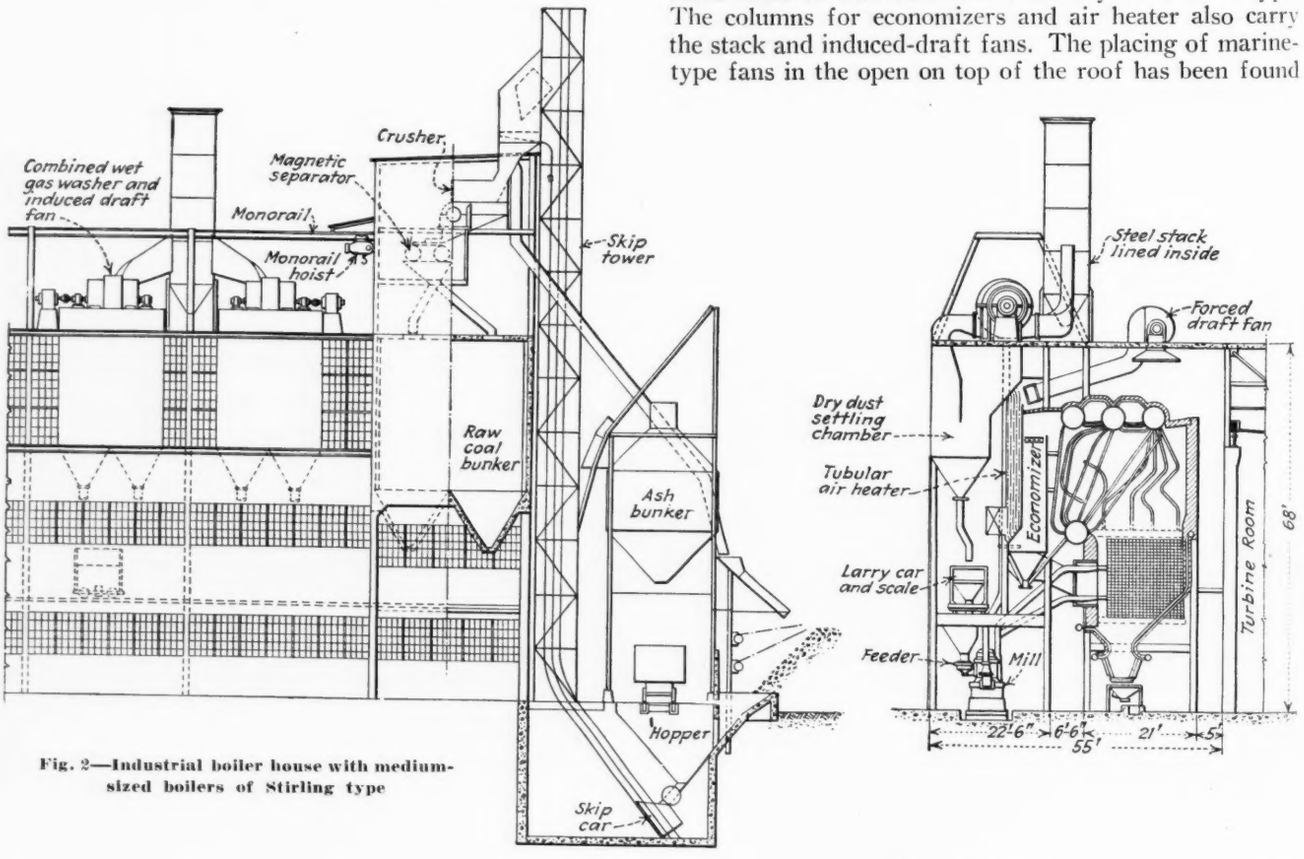


Fig. 2—Industrial boiler house with medium-sized boilers of Stirling type

quite satisfactory. Fig. 3 is a modern boiler design for a a large steel mill with 10,000-sq.ft. boilers, blast-furnace gas and pulverized-fuel firing. The essential features are the same as shown by Fig 2, except that an over-head bunker of the conventional type has been maintained. By corner firing of gas the front wall of the combustion chamber is left entirely available to the pulverized-fuel burners. In this way the height of the combustion chamber is reduced. The building space is about 130 cu.ft. per 10 sq.ft. of boiler surface, which, compared with good practice of a few years ago, is a saving of 30 per cent in volume and more than $6.50 in the cost per unit of capacity.

An example of a small plant with two 5,000-sq.ft. boilers is shown in Fig. 4. Instead of a conventional overhead bunker a silo on the outside of the plant is used. If the plant had overhead bunkers the total cost would be about the same, but only half as much coal could be stored as in the case of the silo. Other advantages of a silo are absence of dust and coal gases and better natural lighting of boiler house. Fig. 4 shows only two mills for two boilers instead of three mills for two boilers. Nevertheless, 100 per cent spare capacity will be obtained, as each motor, mill and its feeder is large enough to take care of two boilers in case of emergency. If one mill should fail the pulverized-fuel switch will connect the other mill to both boilers. During such overloads the boiler efficiency will naturally be lower.

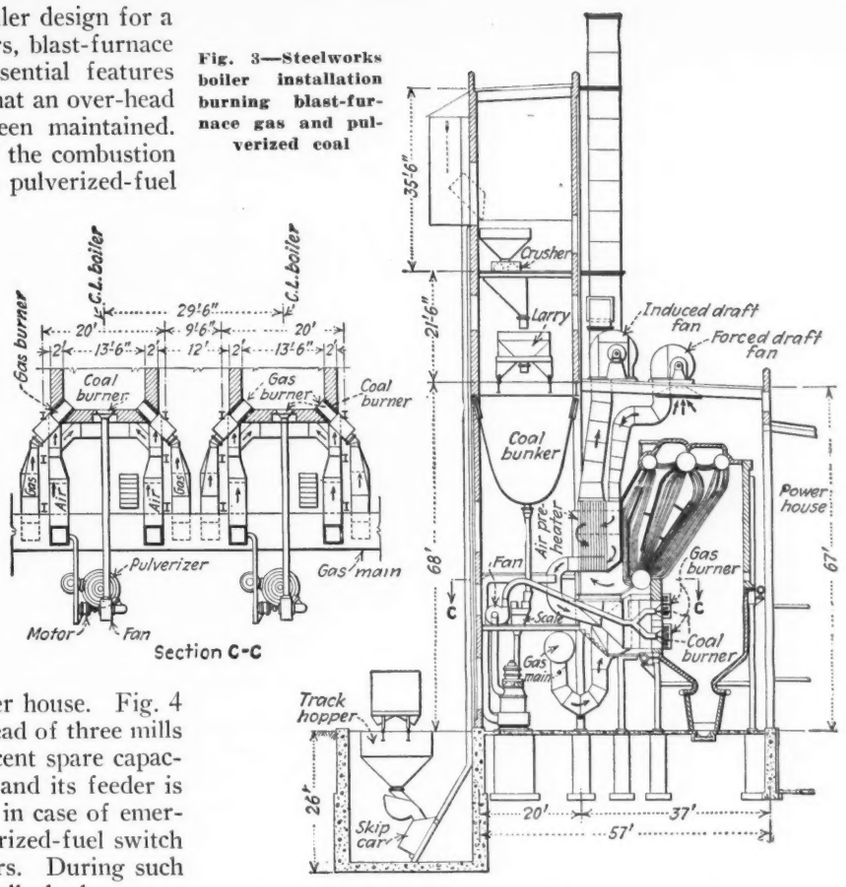
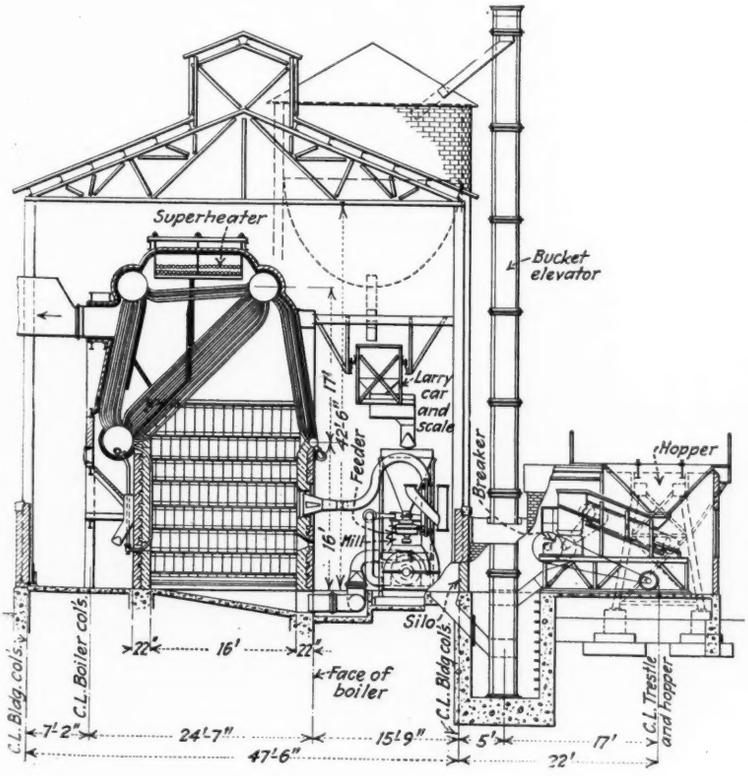


Fig. 3—Steelworks boiler installation burning blast-furnace gas and pulverized coal

Importance of Planning

The importance of careful planning cannot be overemphasized. A careful estimate must be prepared before any detailed designs can be completed. Yet in the hands of competent engineers the actual monetary outlay at the time of completion of the plant will be within a few per cent of the estimated value. Inaccurate estimating often leads to additional appropriations, which are unpleasant to all parties concerned.

Ordering the various parts is another important factor and correct scheduling of deliveries and storing of material will avoid expensive delays in the erection.



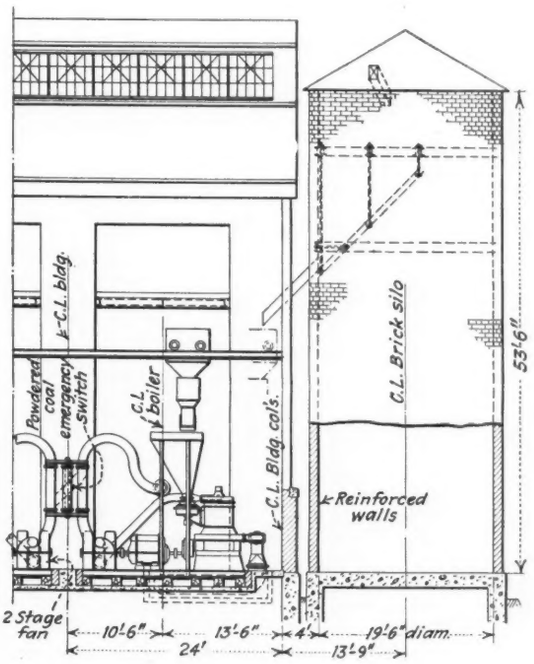


Fig. 4—Small industrial boiler house with silo coal storage and unit mills

Hot-Process Softener Compared With Evaporator

The much-mooted question of evaporator vs. hot-process softener for make-up water is here discussed from the viewpoint of a manufacturer of hot-process softeners

By J. D. YODER
Cochrane Corporation

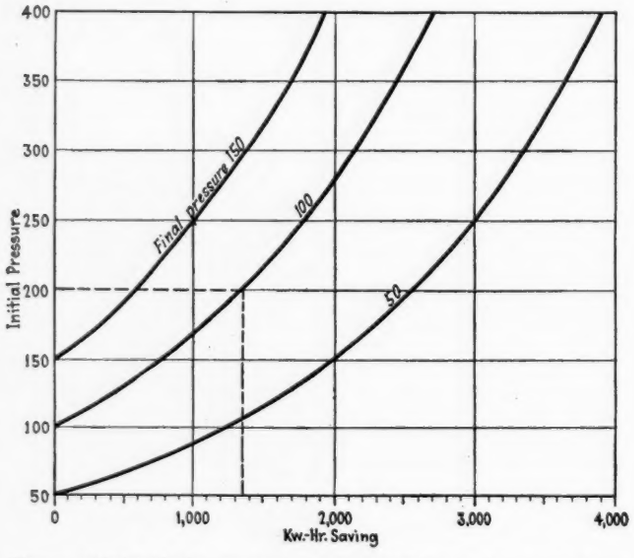
SOME have felt that evaporated feed water is necessary with boilers operating at high pressure and with a high percentage of make-up. Experience proves this to be untrue. Plants are now operating at 400 lb., 600 lb., and 750 lb. pressure with 100 per cent make-up softened by hot-process softeners, and with protection against scale and corrosion.

Theoretically evaporators always supply pure distilled water with no mineral solids. Actually there are always some solids in the distillate.

Chemicals Used With Evaporators

Due to the presence of some mineral solids in the distillate from evaporators, and the possibility of condenser leakage, chemical treatment of boiler water is generally practiced, even with evaporators, either to prevent scale or to guard against embrittlement and corrosion.

Where the water is high in hardness, (over 10 grains per gallon) it is desirable to pre-treat the evaporator feed. In such cases the capacity of water softener required is practically the same as if no evaporator were used.



Power obtainable by expansion of 100,000 lb. of steam per hour

The evaporator will, of course, reduce the sodium salt content of the water, whereas the softener will not. These sodium salts are removed by the blowing down of the evaporator. When no evaporator is used, they are removed by blowing down the boiler.

To keep down the amount of evaporator blow-off, evaporator manufacturers and operating engineers frequently prefer that evaporator make-up be treated with lime only. This reduces the carbonate hardness to a low degree but does not remove the calcium sulphate. Owing to the lower temperature of water in evaporators, the calcium sulphate will form less scale in the evaporators than it would in the boilers at the higher temperature.

Furthermore, if the water in the evaporator contains very little calcium carbonate the scale that does form can be cracked from the evaporator tubes much more easily when passing the cold water through the tubes.

An important advantage of the hot process softener is that it serves as a feed heater, heating the feed water to steam temperature with exhaust or bled steam; that is, the water is heated to the temperature at which the steam is bled.

Pressure Drop Represents Available Power

When using bled steam an evaporator exhausting into a condenser in the feed line replaces steam that could otherwise have been bled from the turbine at the lower pressure. The power which could have been produced by expansion of the steam through the pressure interval occupied by the evaporator has a value which must be included in the cost of operating an evaporator.

This cost is particularly great with the so-called transformer type of evaporator, which is sometimes offered as a means for producing the make-up water in industrial plants where a large amount of make-up is required. This type of evaporator may receive exhaust steam and supply steam at a lower pressure for heating systems and process requirements.

This loss of power is shown on the accompanying chart for 100,000 lb. of steam evaporated at 50, 100

and 150 lb. pressure and with stated pressures of the steam supplied to the evaporator. The less the difference in pressure between the steam supplied and the steam evaporated, the less will be the power cost of evaporation, but the greater will be the fixed charges on capital investment because of the greater heating surface required.

The chart shows, for example, that if steam is supplied to the evaporator at 200 lb. pressure and vapor is taken off at 100 lb. pressure, there will be a net loss in power, compared with bleeding steam at the lower pressure, of 1350 kw.hr. for each 100,000 lb. of make-up water thus obtained. At ½ c. per kilowatt-hour this represents a charge of $6.75 for each 100,000 lb. of make-up.

The curves are based upon a typical condition curve plotted on a total heat-entropy diagram, for the following condtitions:

Initial steam pressure	450 lb.
Initial steam temperature	700 deg. F.
B.t.u. value of coal	14,000
Pounds of coal per kilowatt	1.5
Steam turbine efficiency	78 per cent from throttle to 5 lb. gage bleed point
Boiler efficiency	85 per cent
Cost of current per kw.-hr.	½ cent

Bled steam available at 5 lb. for heating water in open heater before going to evaporator as well as for softening.

For different plant conditions the curves will not be strictly accurate, but will still give a fair measure of cost of make-up water by means of evaporators using high-pressure steam. By interpolation the curves can be used for intermediate pressure within the range of the chart.

The purpose of an evaporator is ordinarily to reduce to a minimum the solids in the feed water, and correspondingly the amount of blow-down required. With sea water, for example, an evaporator is a necessity. With the make-up ordinarily available, having a low mineral solid content, the quantity of blow-down, even where all of the make-up water is treated in the softener, becomes negligible. For example, if the make-up water as represented by the analysis of Lake Michigan water given below contains 106 parts per million of total solids after treatment, and if a total concentration of 2,500 parts per million (150 gr. per gallon) of solids is permissible in the boiler, a blow-off of 4.2 per cent would suffice with 100 per cent make-up.

For this percentage of make-up, an evaporator would be impracticable. In an industrial plant using steam for processes and requiring a make-up of 20 per cent, the softened water would necessitate a blow-off of only 0.84 per cent of the water fed to the boiler. In a condensing plant using only 3 per cent of make-up, the boilers would not need to be blown down at all for the first 18 days, assuming the full contents of the boiler to be evaporated once every 20 minutes. After that time the boilers would require a blow off of only 0.13 per cent.

Even the small quantity of blow off required in an average plant using a small amount of make-up water is not to be debited in its entirety to the softener as compared with the evaporator, since the evaporator also must be blown down and the quantity of water blown down from the evaporator will in all probability be about the same as that blown from the boiler, depending entirely upon whether or not the evaporator can deliver dry steam without priming with a lower or a higher concentration than can the boilers.

Assuming that both boilers and evaporators can be operated satisfactorily with a concentration of 2,500 parts per million total solids, the Lake Michigan water assumed will require a blow-off from the boilers of 4,200 lb. (4.2 per cent) for each 100,000 lb. of make-up fed to the boilers, as will also the evaporator. The difference in heat lost in the blowdown is in favor of the evaporator by the amount that the heat of the liquid of boiler water at 450 lb. pressure exceeds the heat of the liquid of the evaporator water at 100 lb. pressure, or 132 B.t.u. per pound.

For 4,200 lb. blow-off this represents a loss of 554,000 B.t.u., which, however, can easily be recovered by blowing off the boilers continuously into a flash tank at 100-lb. pressure for the process requirements. This will produce 630 lbs. of flashed steam and reduce the amount of steam that could otherwise have been bled from the turbine at 100 lb. pressure. The amount of power that could have been produced by expanding 630 lb. of steam at 450 lb. pressure to the 100 lb. pressure bleed point represents the loss due to blowing down boilers chargeable against the softener or to be credited to the evaporator.

Applying the curves, 630 lb. of 450 lb. pressure steam expanded to 100 lb. pressure in the turbine is capable of producing approximately 19 kw.-hr. of power. At ½c. per kilowatt-hour this represents a charge of 9.5c. on account of the necessary boiler blow down for each 100,000 lb. of water softened.

As already pointed out, if the water contains more than 171 parts per million it should be softened before delivery to the evaporator, so that the cost of chemicals for complete softening will be the same with evaporator as without evaporator at boiler pressures below 250 lb. per square inch[1]. At higher boiler pressures, water fed directly to the boiler would need supplementary phosphate treatment, but the difference in chemical cost would be only the cost of the phosphate. For water with less than 171 parts per million hardness, as, for example, Lake Michigan water, the analysis of which follows, softening may not be necessary with the evaporator.

LAKE MICHIGAN WATER

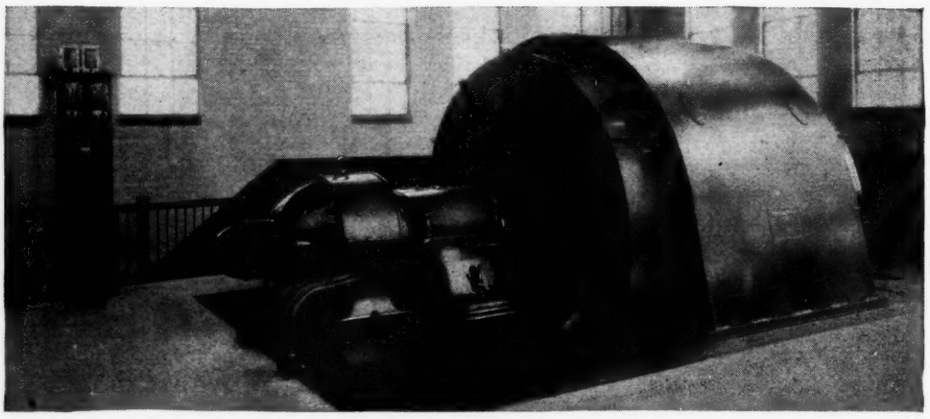
	Raw		Treated	
	P.P.M.	EQ.P.M.	P.P.M.	EQ.P.M.
Calcium	37.4	1.87	6.0	0.30
Magnesium	10.0	0.82	2.0	0.16
Sodium	8.3	0.36	23.0	1.00
Iron oxide	2.0	0.11	2.0	0.11
Silica	5.4	0.18	5.4	0.18
Bicarbonate	161.0	2.64	—	—
Carbonate	—	—	30.0	1.00
Sulphate	17.0	0.35	17.0	0.35
Chloride	4.0	0.11	4.0	0.11
Totals solids	163.0	—	106.0	—
Hardness as $CaCO_3$	135.0	2.69	23.0	0.46

With this water the use of an evaporator would save all chemicals otherwise required for softening, including:

A—14.2 lb. hydrated lime per 100,000 lb. water@0.75c.	10.7c.
B—2.8 lb. Sodium carbonate per 100,000 lb. water@2c.	5.6c.
C—2.0 lb. monosodium phosphate per 100,000 lb. water@8c.	16.0c.
Total cost of chemical for treatment of 100,000 lb. of water.	32.3c.
Cost of boiler blow-off per 100,000 lb. of water softened as computed previously	9.5c.
	41.8c.

If the cost of chemicals plus the cost of boiler blow-off in the case of the softener is compared with the $6.75 worth of power sacrificed by the evaporation of 100,000 lb. make-up as given above, there is evident a saving of $6.33 per 100,000 lb. in favor of softening. This figure should be corrected for relative costs of equipment, maintenance costs, chemicals which must be fed directly to the boiler to prevent scale and corrosion even though evaporators are used, etc. Such charges can readily be computed for an individual case and should be considered by the engineer designing the plant.

[1]If the evaporator make-up is softened with lime only the cost of chemical treatment will be less than would be the cost of boiler feed treatment by the saving of soda ash.



Synchronous condenser with direct-connected main and pilot exciters to give quick-response excitation

By C. LYNN

Power Engineering Department
Westinghouse Elec. & Mfg. Co.

Quick-Response Excitation for Alternating-Current Machines

What quick-response excitation is as applied to synchronous machines, how it may be obtained and the condtions under which it may be used advantageously

QUICK RESPONSE excitation means changing the field current of an alternating-current machine in an extremely short time to compensate for a changed condition in the machine, such as in load. A simple example of this is that of a synchronous motor excited from a constant-voltage source but having a fixed resistance in series with its field coils, Fig. 1. The synchronous motor's field coils are wound for 125-volts and excited from a 250-volt source, but with the resistor in series to reduce the voltage at the slip rings to 125 volts. The resistance is shunted by a contactor controlled by a closing coil acted upon by the load current through the current transformer.

Under normal operating conditions the contactor is open, and excitation to the motor is supplied at 125 volts, giving normal field condition. When an overload is applied the line current increases, causing the contactor to close and short circuit the resistance, thus applying 250 volts to the field coils. This increase in field strength keeps the motor from pulling out of step during the heavy load period. When the overload is removed the contactor opens and the motor again operates with normal excitation.

When two or more alternating-current generators are operated in parallel a change in one generator's excitation will not change the load on it, or vary the voltage of the generator. The change in excitation will cause a change only in the wattless current circulating between the generators. To change the load carried by any one of the generators, it is necessary to change the power output of the prime mover driving the machine. This can be done by adjusting the governor to cause the prime mover to increase or decrease its speed. For example, adjusting the governor to cause the prime mover's speed to increase will result in the generator taking more load. However, an increased power output of the prime mover does not necessarily increase the speed of the generator, since all machines operating in parallel must run at a speed fixed by the frequency of the system and the number of poles in the generators. Adjusting the governor to cause the machine to take more load advances the phase position of the rotor of this generator and causes it to take more load and decrease the amount of wattless current flowing in its windings.

When an alternating-current generator controlled by a voltage regulator is operating in parallel with other generators, located at different places but feeding a common transmission system, the regulator maintains the voltage constant by supplying the necessary direct-current excitation. If the direct-current excitation supplied to any generator is insufficient for its load, a wattless current will flow in the armature circuit, to magnetize the machine and to provide, within certain limits, for the deficiency in direct-current excitation. Above this limit, which depends on the machine's design constants and its load, the excitation is insufficient for the generator to carry the load and it will pull out of step. If the direct-current excitation could be increased as the load is increased the pull-out point would be raised and the generator would remain in step.

Suppose an alternating-current generator supplying power to a transmission system had a heavy overload

suddenly thrown on it, such as a short circuit on the system. A heavy current would flow in the generator armature and in the line up to the point of the short circuit. This current would demagnetize the generator's field, causing its voltage and that of the transmission line to drop. The decrease in voltage would cause synchronous machines supplied by the generator on other transmission lines to fall out of step, as well as those on the damaged line.

If, however, the direct-current excitation supplied to this generator were increased as the overload comes on, the demagnetizing of the armature will be opposed by the increase of direct-current magnetization. There would then be little change in the air-gap flux of the alternator, with only a correspondingly small reduction of voltage. This would prevent the synchronous machines, supplied by the generator, from dropping out of step. It is essential, however, that the increase in direct-current excitation does not lag in time very far behind the demagnetization of the armature, or there will be an appreciable drop in the voltage of the alternating-current generator. Since the torque against pull-out varies approximately as the square of the alternating-current voltage, the importance of maintaining this voltage is apparent.

Maintaining System Voltage

To maintain the alternating-current system voltage, quick-response excitation is necessary and can be accomplished in a manner similar to that shown in Fig. 1 for the synchronous motor. This method except for small machines, is not feasible, because the loss of power in the resistor would be uneconomical and the contactor would be too sluggish in its action. The excitation must be increased with an increase of load approximately in time with the latter and it must also be reduced in a similar manner when the overload is removed.

Instead of a constant-voltage source of excitation and a resistance to vary the voltage applied to the field, an adjustable-voltage direct-current generator is used. Its field current is controlled by a voltage regulator. The regulator is operated by the voltage of the alternator, and the exciter may be self or separately excited, as will be discussed later.

Fig. 2 shows a diagram of connections for a simple voltage regulator, an alternator and an exciter as usually employed in power stations, where quick-response excitation is not ordinarily used. In this case, the speed of response of the exciter, that is, its rate of build up and down of armature voltage, is ordinarily between 35 and 50 volts per second. The contactors are either all open or all closed simultaneously. They are continually vibrating, opening or closing the circuit around the shunt-field resistor. The average voltage developed by the exciter, at any given time, depends upon the percentage of total time the contactors are closed. The contactors are controlled by the alternator's voltage. When this voltage drops, the regulator's contacts close and the exciter's voltage increases. This increase of exciter voltage raises the alternator's voltage and causes the regulator's contacts to open, after which the exciter's and alternator's voltage decrease. This action goes on continually, keeping the alternating voltage approximately constant, irrespective of the change of load on the generator.

Fig. 3 shows the saturation curve of an ordinary self-excited exciter. The no-load saturation curve, or the exciter terminal voltage corresponding to any given

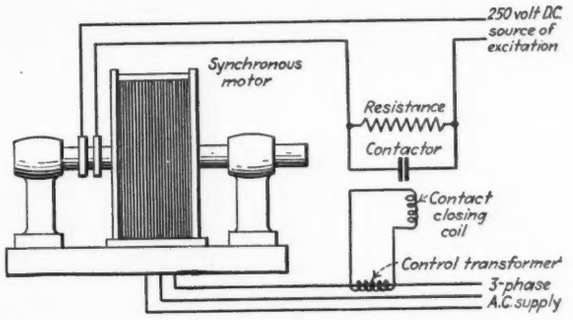


Fig. 1—Synchronous motor arranged for quick excitation of its field coils

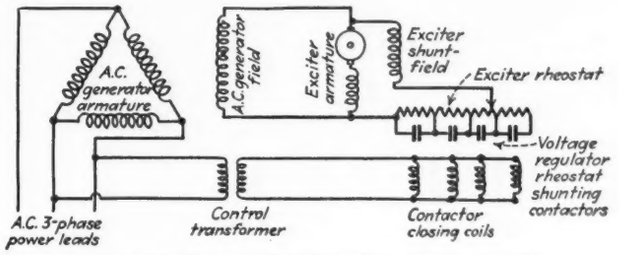


Fig. 2—Diagram of connections for a simple automatic voltage regulator

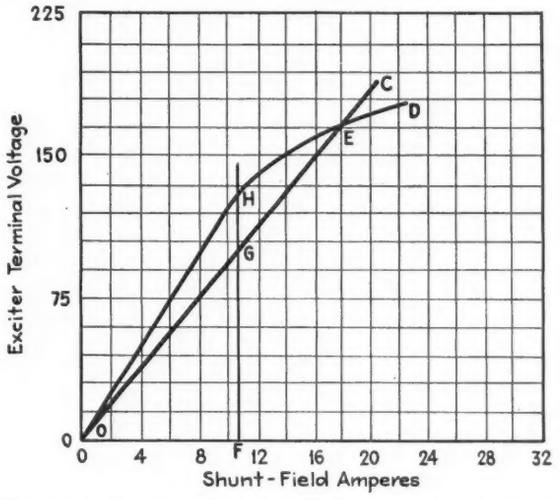


Fig. 3—Saturation curve of ordinary self-excited exciter

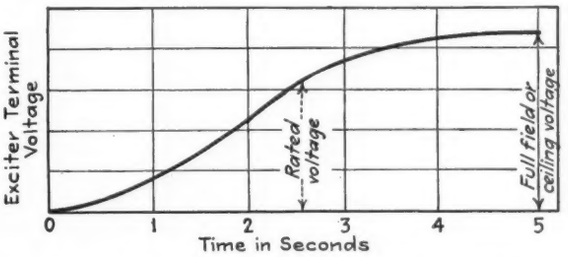


Fig. 4—Curve showing the rate of voltage increase for a self-excited exciter

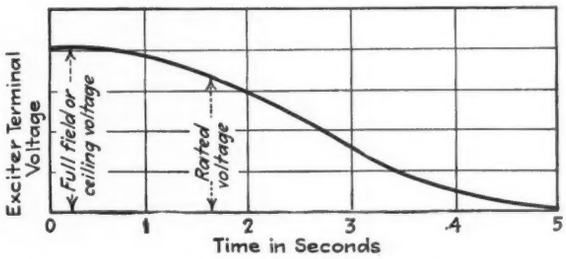


Fig. 5—Curve showing the rate of voltage decrease for a self-excited exciter

field current based on the exciter operating at constant speed, is shown by the curve *OD*. The voltage required at the exciter field-coil terminals to produce the saturation curve is represented by the line *OC*. In other words, if the exciter were separately excited and the voltage gradually increased across its field coil terminals as represented by line *OC* the voltage at the armature terminals would increase along curve *OD*.

Consider the exciter as operating with a shunt-field current corresponding to *OF*. In this case the voltage supplied by the exciter will be *FH*. With the contactors on the regulator closed the voltage required across the shunt field, corresponding to a field current of *OF*, will be *FG*, which is less than the available voltage *FH*. Thus the excess voltage *GH* is available for increasing

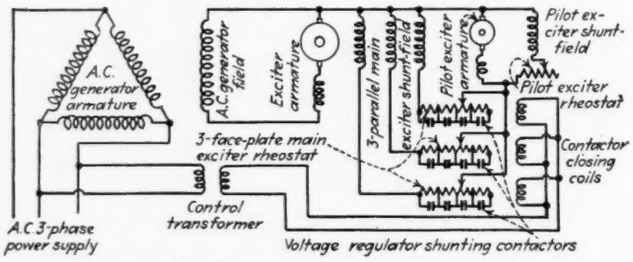


Fig. 6—Connection diagram of voltage regulator where the exciter field coils are connected in parallel

the exciter-field current and for building up the exciter voltage until the point *E* is reached. At this point the two voltages are equal and there will be no further increase of exciter field current or voltage. This maximum voltage of the exciter is often referred to as its "ceiling" voltage. For any value of field current the available voltage for increasing the exciter-field current, and thus the flux and armature voltage, will be represented by the vertical distances between the lines *OC* and *OD*. This gives a curve of growth of voltage as indicated in Fig. 4.

When the contacts are open there is insufficient voltage to send the required field current through the shunt-field resistance, plus the external resistance in series with it; consequently it will decrease. The curve of decay of voltage is represented in Fig. 5. For quick-response excitation it will be necessary to increase the rate of build up and decay of the exciter voltage, which is limited, primarily by the inductance of the exciter-field circuit.

The inductance can be decreased by reducing the number of turns in the field winding or by paralleling the field circuits. Where the current is too large to be handled by the contactors the number of turns per pole of the field coils must be increased and the shunt field connected in two or more parallel circuits, Fig. 6, with separate resistances and contactors in each circuit. This gives a reduced inductance, as the time-constant of equal parallel circuits is the same as that of any one of the circuits.

This system of connection decreases the voltage drop across the field coils and increases it across the resistances by this same amount. The loss in the resistances is increased and simply means that the inductance is decreased, which decreases the time-constant that depends upon the ratio of the inductance to the resistance.

A large increase of speed of response can be secured by separately exciting the exciter from a source of constant voltage, usually 250 volts. When a separate small exciter is used to supply field current to the main exciter it is called a pilot exciter. The reason for the large gain in response will be understood by referring to Fig. 7. In this figure *OD* is the no-load saturation curve. *OE* is the shunt-field resistance line with the regulator contacts closed, and line *LE* represents the constant-voltage source of excitation of magnitude *OL*.

For any value of shunt-field current, such as *OF*, the voltage required by the field is *FG*, while the available voltage, for forcing the growth of field current, is *GK* instead of *GH*, as in the case of the self-excited exciter. Thus it can easily be seen why the response is much quicker when the exciter is separately excited. When the contactors are closed and remain closed, the field current is *OM*, the field voltage is *OL*, and the exciter ceiling voltage is *MD*. In this case the growth of exciter voltage will be as indicated in Fig. 8. The corresponding curve of decay of voltage of this quick-response exciter, when controlled by its quick-response voltage regulator, is Fig. 9.

Paralleling the field coils or using a smaller number of turns per pole of a larger-size wire and increasing the amount of external resistance in series, increases the power expended in this field. The power used increases with each reduction in the value of inductance, and increases in resistance in series with the shunt field. This extra loss in the field circuit is what is paid for obtaining quicker speed of voltage change.

There are other factors that affect the speed of voltage response. Shortening the main-pole air gap allows the field current to be reduced, which decreases the energy

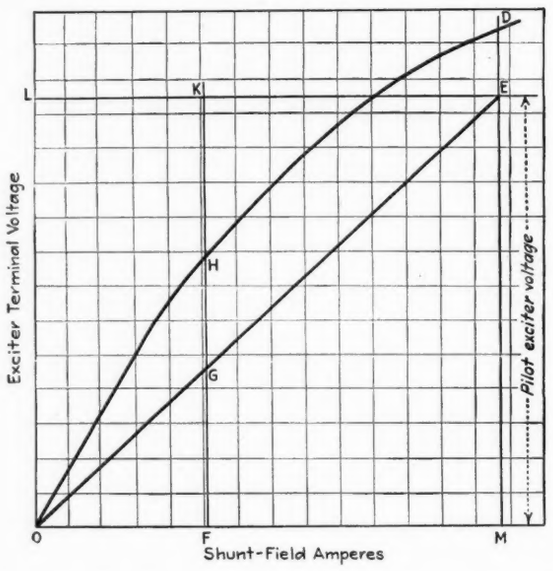


Fig. 7—Saturation curve for separately excited exciter

handled by the contactors of the regulator and reduces the inductance. The higher the rotative speed of the exciter the smaller will be the exciter for a given output. This results in a corresponding reduction of the total flux and inductance, with a proportional increase in the speed, of voltage response.

From the foregoing it is seen that a quick-response excitation system consists of a synchronous machine, excited by a specially constructed exciter designed to build its voltage up and down rapidly, and controlled by a suitably constructed voltage regulator. In many cases a flat-compounded pilot exciter is supplied for excitation of the main exciter. As ordinarily considered, the exciter of the quick-response excitation system must have a voltage response of higher than 100 to 200 volts

per second compared to the usual 35 to 100 volts per second of an ordinary exciter. The voltage regulator of the former must be especially constructed to respond almost instantly to the load or voltage change on the alternating-current generator, and this regulator must not overshoot appreciably or hunt.

Quick-response excitation is not a cure-all, and many power stations are better off without it, as its use would be of no material benefit, especially for small plants with a few hundred or thousand kilowatts' capacity. This system is used to advantage in large stations and in those that supply power to long transmission lines.

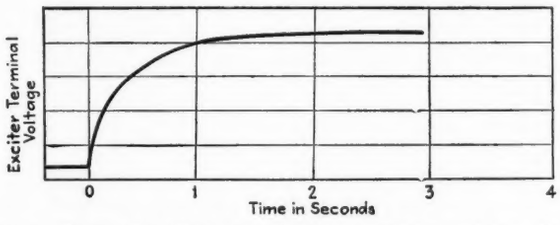


Fig. 8—Curve of voltage growth for separately excited exciter

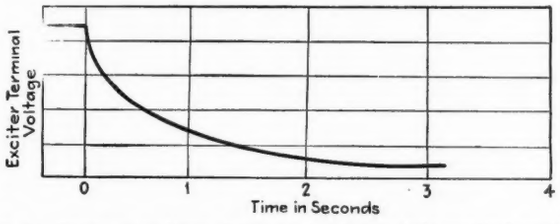


Fig. 9—Curve of voltage decrease for separately excited exciter

Here it improves service by preventing synchronous machines from falling out of step and increases the capacity of the transmission lines during disturbances by holding up the voltage of the generators. In many cases this removes the necessity for additional transmission lines which would otherwise be required to take care of transient conditions.

"The Diesel Engine—A World Viewpoint"

is the subject of a series of articles by Colonel Oliver F. Allen, beginning with Oct. 13 and appearing every second issue.

Development of the diesel has made such progress in the past few years that few, outside a small group intimately associated with this type of prime mover, have any conception of the extent and diversity of its application. The articles will tell the story of diesels in the marine field, in central stations, in industrial plants, on rails and highways, in semi-portable plants and as auxiliaries to steam or hydro.

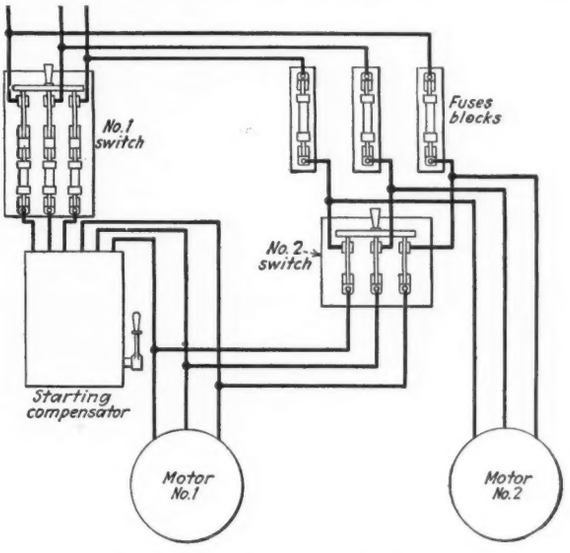
The author, who has long been identified with the oil engine field both here and abroad, has recently returned from Europe and brings first-hand information as to what is being done on the other side.

One Compensator Starts Two Induction Motors

By ELLIS MILLS
Toronto, Ont.

IN OUR maintenance shop there is a 25-hp. induction motor with a line switch and starting compensator. An emergency required installing, temporarily, a second 25-hp. motor, which was in stock. A spare starting compensator was not available and it was not considered safe to try full-voltage starting. It was therefore decided to start the two motors from the same compensator.

A suitable switch and fuse blocks were found in stock. These were connected to the line and the compensator and to motor No. 2 as shown in the diagram. After phasing out to make sure that the low- and full-voltage connections to motor No. 2 had correct phase relation the motors were started. This was done by closing the two switches and leaving the fuses out of the fuse blocks on No. 2 motor. The compensator was then closed to the start position and the two motors started together, after which the compensator was thrown to the full-voltage position. The fuses were then inserted in the fuse blocks and No. 2 switch opened, which connected



Connections for starting two squirrel-cage motors from one compensator

the No. 2 motor to the line through the fuses. After the starting operation No. 1 motor could be shut down if it was not required.

To shut down No. 2 motor when No. 1 is not running, the latter is first started, No. 2 switch is closed and the fuses removed from the blocks; then No. 2 switch is opened to disconnect No. 2 motor from the line. After this is done No. 1 motor is shut down if not required. Both motors may be shut down together after the fuses are taken out of the blocks by opening No. 1 switch.

A fused switch in place of the fuse blocks would have allowed shutting down No. 2 motor independently of motor No. 1, but the switch was not available. As a temporary expedient the arrangement shown in the figure worked satisfactorily.

Ancient Waterwheel Had Curved Buckets

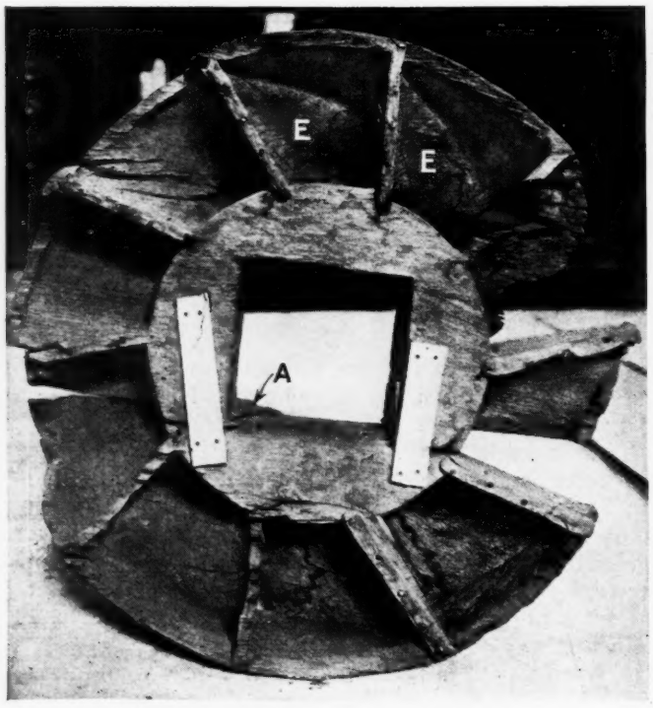
THE OLD wooden hydraulic-turbine runner shown in the photographs is on exhibition in the Arts and Métiers Museum, Paris, France. It dates from about the fourth or fifth century. Its history is unknown, but it was donated to Monsieur H. Tresca, Conservateur des Arts de Métiers, by an unknown collector in 1814, twelve years after the birth of Benoît Fourneyron, the French inventor of a turbine bearing his name. The Fourneyron turbine is not unlike that shown in the picture. The wooden turbine is in the museum with the section of another waterwheel also dating from about the fifth century and brought to the museum in 1864 by Monsieur Deligny. The photographs were supplied by Hugh L. Cooper, consulting engineer, New York City, and the above information was obtained by John G. Hopper, consulting engineer, Paris, France, directly from the museum where the turbine runner has been placed on exhibition.

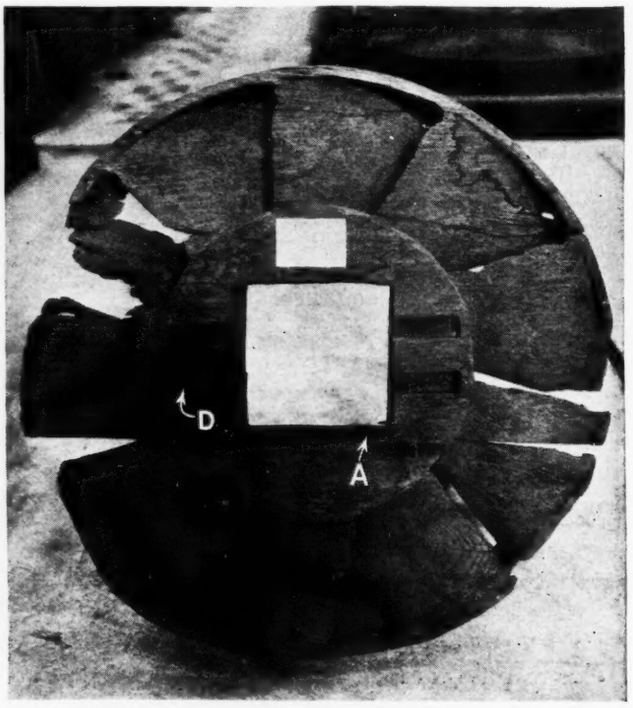
The wheel shown in the figures is in two parts. Apparently it was originally made in one piece and broke in two. This is indicated by the slivers attached at *A*, Figs. 1 and 2. These would not have been left in place if the wheel had been made in two parts. A study of the wood's grains at *A* and *B* in Fig. 3 shows that the lower half is a different piece of timber than the upper. It would therefore appear that the wheel was originally made from one piece of wood and was damaged or failed, and that what is shown as the lower part of the wheel in the pictures is a repair. The lower section is attached to the upper by square dowels, as can be seen at *C*. The buckets have a curved form, indicating that the builder had a good idea of correct hydraulic principles in waterwheel design. This design comes much closer to applying correct principles than some wheels that appeared on the market during the nineteenth century.

The wheel was used on a shaft with a square end, as was the practice in early times, and was held in place by a U-shaped key recessed into the hub as at *D*, Fig. 2.

In several places effects of erosion are clearly apparent, particularly at *E*, Figs. 1 and 3. At other places the softer wood has been worn away from between the hard contours of the growth rings.

Fig. 3—The curvature of the buckets can be seen in this picture





FIGS. 1 AND 2—SHOW OPPOSITE SIDES OF THE WOODEN WATERWHEEL

The sliver attached at *A* indicates that the wheel was originally made from one piece of wood and that the lower section broke off. A study of the wood's grains gives evidence that the bottom section in the photos is not the original wood and is undoubtedly a repair made when this section failed.

READERS' COMMENTS

Brazing Carbon Steel

THE ARTICLE entitled "Tapping a Steam Main Under Pressure," by J. T. Towlson, in the Aug. 25 number, would lead one to believe that air-hardening or self-hardening steel, as it is sometimes called, must be used in brazing if the temper or hardness is to be retained afterward. Fortunately this is not true, as carbon steel (usually called tool steel) can be brazed, hardened and tempered easily.

Air-hardening steel is an alloy usually containing from 5 to 15 per cent tungsten (although the percentage is sometimes as high as 24 per cent) and from 0.4 to 2 per cent carbon. The property that tungsten imparts to steel is that of hardening in the air, after heating to the required temperature. This property makes it valuable for some kinds of work, but it is not necessary to use air-hardening steel because it is brazed. This steel is not usually carried in stock, as is the more common carbon steel, because it is an alloy.

To braze carbon steel for tempering, copper only is used instead of the usual spelter of copper and zinc. No special care need be taken over an ordinary brazing job except that the parts must be heated to a higher temperature. Pure copper melts at about 1,980 deg. F., while spelter melts at about 1,600 deg. After brazing, the carbon steel should be annealed, hardened and drawn. To anneal low-carbon steel, heat to about 1,650 deg., and high-carbon steel to between 1,400 and 1,500 deg., and allow the steel to cool at a rate slow enough to prevent hardening. After annealing, heat to about 1,475 deg. and quench in oil and then draw or temper by reheating to the desired temperature or color, depending upon what the steel is to be used for afterward. It is evident that all the heat-treatment given the steel is at a lower temperature than that at which the brazing takes place and therefore does not affect the brazing.

I have used copper for brazing both carbon and high-speed steels for use in milling cutters and reamers and have experienced no difficulty in tempering them later.

Rockland, Mass. BURTON W. WHEELER.

Filtering Diesel Lubricating Oil

WITH reference to the article by J. Willard Peterson, in the Sept. 15 number on "Filtering Diesel Lubricating Oil," I should like to call his attention to a simple method by which he can improve the quality of the oil and increase the recovery, also doing away with the settlings that accumulate in his storage tank. The method that I recommend is this:

In the five-barrel tank place 200 gal. of oil, adding to it three pounds of soda ash which has been dissolved in a gallon or two of water. Then pipe live steam directly into the bottom of the tank, to raise the temperature to 180 to 200 deg., before discharging the oil through the centrifuge. With very dirty oil connect a quarter-inch hot-water line into the feed pipe of the centrifuge.

With a properly designed machine the carbon will be flushed out as a thick paste which is almost solid when cold, and the machine can be kept running indefinitely. This is preferable to cleaning out the tank; moreover, with well-settled oil the dregs may be stiff enough to shovel and yet contain 75 per cent of good recoverable oil which would otherwise go to waste.

Should no steam be available the oil may be heated by the exhaust from the engines, and the soda solution with a little extra water added, and the mixture stirred by hand, or mechanically, compressed air being effective, though live steam seems to coagulate the carbon to a slight degree.

Silicate of soda and trisodium phosphate may be used, but are more expensive and usually not so available. Sal soda may be used in place of soda ash, but it will require two and one-half times as much.

This method gives a clean oil, and with the proper adjustment of the centrifuge less than 0.02 per cent of water, which is not enough to do any harm.

Cleveland, Ohio. L. R. BAKER.

Is Customer's Inspection of Plant Equipment Necessary?

WITH REFERENCE to the article by H. M. Friend in the Sept. 1 number on the subject of customer inspecting, I should like to add the following comments:

1. Most responsible manufacturers maintain their own inspection department. However, if the chief inspector of such departments is not directly responsible to the works manager instead of the plant superintendent the inspection is not likely to be so thorough.

2. Customer inspection of a product perks up the morale of the manufacturer's inspection force in that defects are not so likely to slip by. Customer inspection does not relieve the manufacturer of any responsibility. But it works to the good of the manufacturer in that one more barrier is set up to eliminate defective or incorrectly manufactured products, which all responsible manufacturers strive to avoid. A case may be cited where a large valve for a turbine had passed all detail inspection by the manufacturer's inspectors and was finally observed by the customer's inspector during shop assembly of the unit to contain a major error.

3. On large equipment the custom is for the manufacturer to agree to guarantee the replacement f. o. b. his works of any part proving defective within one year after operation. However, the cost to the manufacturer of such replacement will generally prove relatively small when placed beside the loss sustained by the customer in the enforced idleness of the equipment occasioned by the replacement of the defective part. I know of an instance where approximately 40 tons of steel castings were rejected before sufficient acceptable castings were procured for the job. Were one of the castings to fail in service it would entail the loss of output of a 40,000 kva. generator unit for at least 50 hr., plus the labor cost of making the replacement. The value of a casting is approximately $150.

4. On large projects it is necessary that all of the items of construction be so coordinated that no delays will occur in the field. The customer's inspector is also aware of the status the equipment should be in at any particular stage of manufacture, so that shipment and delivery to the job site will be made as scheduled.

Milwaukee, Wis. A. H. MYERS.

Structural Steel and Pipe Welding Featured in A. W. S. Fall Meeting

Boston section, backed by city, offers lavish program of entertainment

FROM Sept. 21 to Sept. 25 the Copley-Plaza Hotel, Boston, Mass., was the scene of numerous technical sessions of the American Welding Society, there assembled for its Fall meeting. Welding of structural steel and of piping were particularly stressed in the program.

Backed by city officials, the energetic Boston section of the A.W.S. was able to provide exceptional entertainment at the annual banquet and for the women throughout the week.

Following the custom of recent years, the Fall meeting was held in collaboration with the American Society of Steel Treating, which held sessions in the near-by Statler Hotel. At the latter were also held a few meetings of the A.S.M.E. and the American Institute of Mining and Metallurgical Engineers.

Joins SteelTreaters in Exhibition

Simultaneous meetings of the welding engineers and the steel treaters made practical the holding of a combined exhibition as in previous years. These have come to be of great importance. The exhibition this year, held on the great Commonwealth Pier, included many welding and cutting exhibits. One of these was a machine (in operation) for cutting several identical pieces simultaneously from plates. The cutting torches were mounted on a pantograph set-up, guided by a point moved around a template or tracing.

Structural Steel Handbook

While the fabrication of structural steel by welding is somewhat outside the field of power, the work of the Society along this line is worthy of comment. The A.W.S. has blazed a path in this field which all structural men must follow. For five years the Structural Steel Welding Committee has benefited by the hard work of structural experts, including engineers prominent in United States Steel and American Bridge.

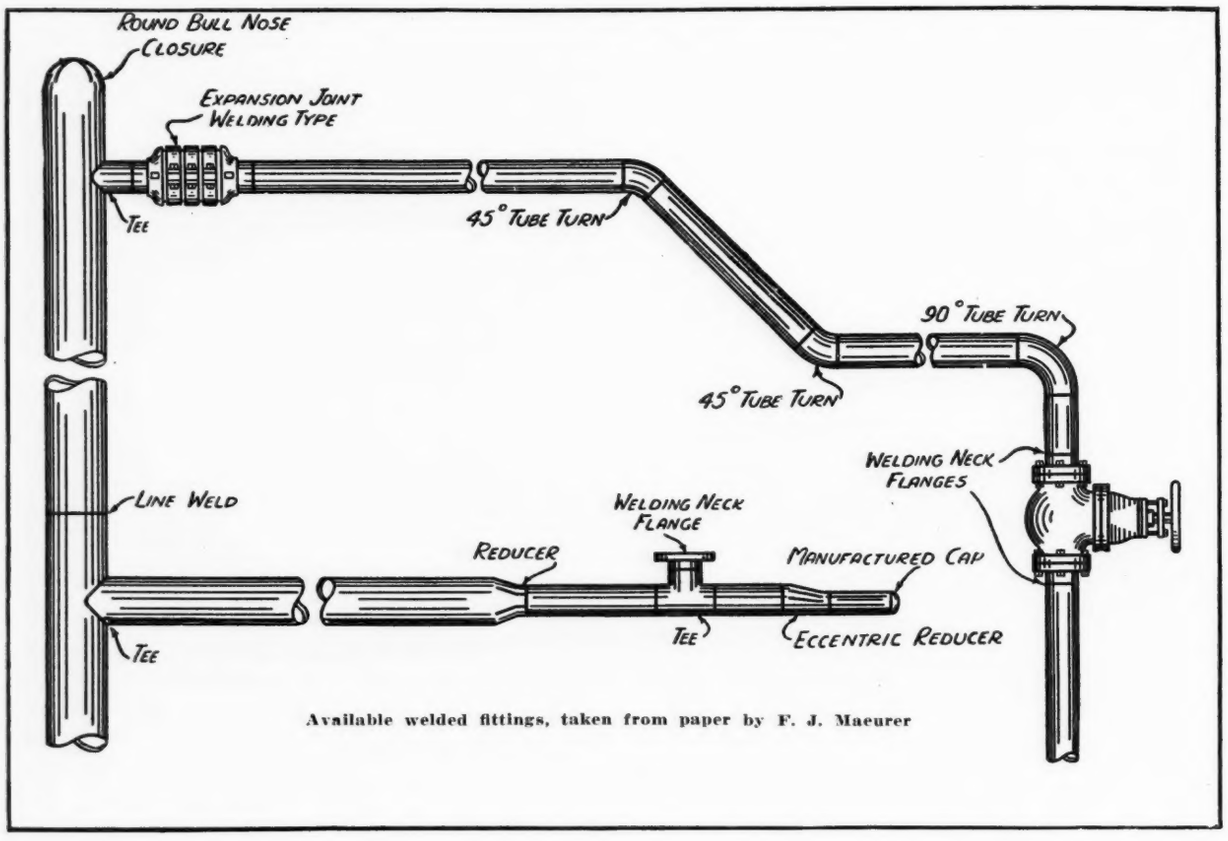
At the meeting was publicly offered a report of this committee referred to by *Engineering News-Record* as the "Welding Magna Charta" because of its significance in this field.

Following commitee meetings on Monday, the convention was opened by E. A. Doyle, president, with a business session on Tuesday morning, followed by a technical session.

In this Albert D. Fish, consulting engineer, described structural welding on a new group of buildings at Yale University. Some of these involved exceptionally complex frameworks.

Column Cut Off in Occupied Building

Another structural paper told a story of possible interest to many power engineers. After the completion of a 14-story building in Wilmington, Del., it was found necessary to widen a driveway. This necessitated removal of the bottom section of a column, leaving the balance of the column to support twelve stories and the roof. The girder welded in to support the upper part of the column was first given an initial de-



Available welded fittings, taken from paper by F. J. Maeurer

flection by a hydraulic jack (loaded to 400,000 lb.) so that after cutting away the lower part of the column no subsidence of the building was noticeable.

Multiple-Torch Cutting

In another paper of Tuesday morning R. K. Helmkamp of the Air Reduction Sales Company described the equipment used for multiple torch cutting controlled from a single guide point and template. A machine of this sort, as already mentioned, was in operation at the exhibition. The afternoon was devoted to a boat trip and shore dinner.

On Wednesday morning J. Kjekstad of the United Dry Decks, Inc., discussed the future of welded ship construction and described two systems of construction particularly adapted to barges.

In the afternoon "Maximum Stress" was the topic of Everett Chapman, who showed the great importance of eliminating sharp notches and re-entrant angles in the design of machines and structures and in their construction by welding.

Another technical paper, by R. A. Weinman of the General Electric Company, dealt with the fatigue properties of welds. H. F. Reinhard discussed the welding of galvanized steel.

It is generally believed that the development of welding has hurt the foundry. In this belief P. J. Horgan of the General Electric Company did not concur. He pointed out that welding had resulted in great improvements in foundry practice.

Investigates Annealing

Thursday's sessions contained a number of papers of particular interest to *Power* readers. One by Charles H. Jennings of Westinghouse Electric and Manufacturing Company, reported an investigation of annealing at temperatures of 1,000 deg. F., 1,100 deg. and 1,200 deg. He found that both the temperature and the soaking time affect the release of stresses and that by proper annealing residual stresses in welded structures can be reduced to a few thousand pounds per square inch.

In the discussion this paper was held up as additional argument for the annealing requirement of the A.S.M.E. welded boiler code.

Advantages of Welded Piping

In a distinctly practical paper Fred J. Maeurer, Air Reduction Sales Company, pointed to the many advantages of welded pipe and fittings in heating installations, listing the following: (1) bevelled pipe costs less than threaded, (2) lower insulation costs, (3) reduced maintenance, (4) no scrap pipe or fittings left over, (5) no pipe threading machinery, (6) any stock lengths of pipe can be used.

In addition Mr. Maeurer pointed to the greatest potential saving of all—the use of thin-walled tubing made possible by the elimination of threads. The paper listed the many welding fittings recently placed on the market, including a Van Stone joint with welding neck. It praised the work of trade vocational schools that teach welding to steam fitters.

The mention of welding schools developed a lengthy discussion. Several pointed to their limitations. Some felt that steam fitters would not attend schools and should be taught on the job by steam fitter welders.

Welding Brass Piping

H. V. Inskeep of the Linde Air Products Company described methods of welding copper and brass piping. He recommends the bell and spigot joint welded at the edge with high-strength rod. The taper is formed with a file and the bell by a driven plug.

H. Samuelson, of Almirall & Company, described methods used in welding piping systems at the Cornell Medical Clinic, New York City.

Lincoln-Stine Curves Develop Argument

An interesting situation developed in the discussion of the paper "Factors Affecting the Weldability of Steel," by Wilmer E. Stine of the Lincoln Electric Company. The paper, presented by Mr. Lincoln, discussed the "Lincoln Stine Equilibrium Curves" for the composition of weldable steel. These curves were printed in *Power,* July 14.

In a prepared discussion F. T. Llewellyn of the United States Steel Corporation challenged the validity of the curves on the basis of extensive tests made by the Carnegie Steel Company. He also stated that it is impracticable to make steel as called for by the curves and that the results in any case could apply only to the carbon arc.

Others raising objections to these curves were Dr. Herty of the United States Bureau of Mines and W. B. Miller of Linde Air Products Company.

In the concluding session on Friday morning Ira T. Hook and M. Powell described the welding of a large Everdur pressure vessel.

High-Speed Oxy-Acetylene Process

A new, extremely rapid process of oxy-acetylene welding was described by T. W. Greene of the Linde Air Products Company. The speed is 3 to 3½ times that of the old process, according to Mr. Greene.

The process involves the use of a new torch with supports, rod feed and special rod preheating flame.

The welding is done with a carbonizing flame and with a rod with low melting point, high-carbon iron-alloy surface. In welding the flame is pointed back against the weld.

The chief application has been to field pipe lines where 20-in. pipe joints ($\frac{5}{16}$-in. wall) are made on the average in seventeen minutes. The operation was made clear with the aid of a two-reel motion picture.

In the concluding paper, also illustrated with motion pictures, Charles Kandel of the Craftsweld Equipment Company showed applications of underwater gas cutting.

Welded Pipe and Fittings In Heating Installations*

During the past few years rapid strides have been made in the welding of pipe in heating installations, superseding the older method of screwed fittings. This has progressed so far that at present an all-welded heating installation is accepted by architects, building owners, heating contractors and plumbers and steamfitters.

The paramount reason for this attitude is that journeymen plumbers and steamfitters have finally become convinced that they must learn pipe welding or compete with another trade. They now find it possible to do this efficiently and economically in their local vocational schools, which have been supplied with special pipe welding courses, lectures, charts, pipe templets and engineering assistance.

As an indication of this trend, there are now approximately 175 vocational schools in the United States teaching pipe welding to plumbers and steamfitters. The demand for more classes is so great school officials predict that many more will undoubtedly be started within the next year.

As a result of this vocational school training of plumbers and steamfitters, architects now specify welded joints, and heating contractors find themselves in the enviable position of being able to bid on welded installations. Their journeymen know how to weld pipe, and they no longer find it necessary to trust their welding on heating installations to men who have had little or no training in this type of work.

There are many reasons why a welded piping installation is now considered standard practice, superseding the old screw-fitted method. The outstanding reason is that it is better. Other reasons are efficiency, economy and weight saving. In considering these, one should include fabrication of joints, fabrication of headers, welding fittings, spacing and tacking, expansion and contraction, adaptability and portability of oxy-acetylene apparatus, and welding piping in the home. The foregoing are not all the advantages that a welded piping installation has over the old screw fitted one, but they are some of the outstanding ones.

Ease of flow and reduction of friction losses, due to smoothness of welded joints, are of economical value as they affect the cost of delivering steam to its objective. These factors are of vital interest to the owner of the building who is interested in furnishing steam at the least possible cost.

The over-all economy that is effected by a pipe welded installation over the old method of screwed fittings is made up of several factors which would require much space to describe fully. They start at the pipe mill and actually extend beyond the finished installation itself.

*Abstract of paper presented before the Fall Meeting of the A.W.S., in Boston, Sept., 1931, by Fred J. Maeurer.

Expansion Fits With Liquid Air

For a shrink fit one heats the outer member. The same result may be achieved by precooling the inner member with liquid air. Expansion fits are sometimes more convenient than shrink fits

By E. V. DAVID and W. S. FARR

Applied Engineering Department, Air Reduction Sales Co.

A COMPARATIVELY new industrial use for liquid air which offers interesting possibilities is its application as a medium for making expansion-fits.

The term "expansion fit" is used because it describes the operation accurately. In preparing two parts for an expansion fit, the pin, shaft, bushing, etc., are machined to a diameter slightly larger than that of the hole in the part in which it is to be fitted. The inner part is then cooled to an extremely low temperature by immersing it in liquid air. This causes it to contract in diameter until it slides easily into the hole in the outer part. As the inner part returns to room temperature it expands in the hole with great force, gripping the outer part securely.

Composition of Liquid Air

Liquid air is a mixture of liquid nitrogen, oxygen and other gases of the atmosphere, in varying proportions, depending upon the conditions under which it is produced and used. The proportion of the various constituents has little appreciable effect when liquid air is used in making expansion fits. It is sufficiently accurate for the purpose to assume a liquid with an analysis varying from 40 per cent oxygen and 60 per cent nitrogen to 60 per cent oxygen and 40 per cent nitrogen. The boiling temperature of such a liquid lies somewhere between that of liquid oxygen and liquid nitrogen, depending on its composition, and for estimating expansion-fit allowances may be taken as —190 deg. C. (—310 deg. F.).

Shipping Containers

As liquid air boils at this extremely low temperature, it is necessary to transport it in containers which are open to the atmosphere at all times, to allow free vent for the vapors. The liquid maintains itself constantly at the boiling point. Nitrogen being more volatile than oxygen, the liquid in evaporating gradually becomes richer in oxygen. Just before all liquid has evaporated the residue in a container may consist of fairly pure liquid oxygen.

Shipping containers for liquid air are of the long-necked metal vacuum type. A 25-liter capacity container when standing has an evaporation loss of 4 to 8 per cent per 24 hr. These losses are increased somewhat during transportation, due to motion of liquid.

Refrigerating Capacity

In evaporating, liquid air absorbs heat. However, it remains at boiling temperature as long as any liquid is left. The heat absorbed does not raise the temperature of the liquid, but is utilized entirely in evaporating it. For expansion-fit practice it may be assumed that 200 B.t.u. is required to evaporate a liter of liquid air (or 90 B.t.u. per pound). Inversely, liquid air has the capacity of withdrawing 200 B.t.u. from parts immersed in it, per liter of liquid evaporated. A metal part at ordinary atmospheric temperature is relatively very hot compared to liquid air at the boiling point. If metal is at 70 deg. F. and liquid air at—310 deg. F., the temperature difference is 380 deg. F.

Quantity of Liquid Air Required

When a part is immersed in it, liquid air boils violently and continues to boil until the part has been cooled to the same temperature as the liquid. This may require several minutes with heavy parts. The quantity of heat withdrawn from the submerged part is exactly equal to that absorbed by the liquid air, which, in turn, determines the amount of liquid air evaporated by the part.

As each 200 B.t.u. given off by part will evaporate one liter of liquid air, the shape of the part has no effect on liquid requirements. Material and weight are the only determining factors. If the part is of a form which presents a large heat-radiating surface to the liquid, such as a thin plate, it will cool much more quickly, but the quantity of heat given off will be the same as that emitted by a sphere (which has the least surface in proportion to its volume) of the same material and weight.

TABLE I—LIQUID AIR EVAPORATED IN COOLING METALS

Name of Metal	Weight, Lb. per Cu.In.	B.t.u. Given Off per Lb.	Lb. Cooled per Liter	Liters per Lb. Cooled
Aluminum	0.098	71.4	2.80	0.357
Brass	0.310	33.1	6.04	0.166
Bronze	0.323	34.2	5.85	0.171
Cast iron	0.260	39.5	5.06	0.198
Copper	0.322	29.7	6.73	0.148
Monel metal	0.318	34.2	5.85	0.171
Nickel	0.317	34.6	5.78	0.173
Steel	0.285	34.6	5.78	0.173

Table I shows approximate requirements of liquid air for fully cooling a pound of various metals. It applies only where parts are separate units and are totally immersed in the liquid in cooling. Where only the end of a part, such as a shaft, is dipped in the liquid, heat is rapidly conducted to the liquid through the metal above the liquid and a greater quantity is evaporated than would be required to cool the immersed portion of the part alone.

Liquid-Air Losses

The above liquid-air requirements include only the quantity used in actual cooling of the parts. In estimating the number of liters which must be shipped, enough excess must be provided to allow for the various evaporation and other losses connected with the transportation and use of liquid air. To estimate the number of liters of liquid air to be shipped, for expansion-fit experiments, weigh all parts and calculate liquid required for actual cooling from Table I. Add, say, 50 per cent to allow for working container losses and a further percentage (say 6 per cent per 24 hr.) to cover shipping-container losses.

Liquid Air Vapor for Precooling

The vapor which comes off liquid air as it evaporates is still at very low temperature and possesses considerable refrigerating capacity. Wherever practical it is economical to precool parts in this vapor so that they will evaporate less liquid air when immersed. The vapor may be piped to a separate precooler for parts, or parts may be suspended in a wire mesh or perforated metal basket in the upper part of the working container before they are placed in the liquid.

Contraction of Parts in Liquid Air

The approximate contraction or decrease in linear dimension of parts of various metals, per inch of length or diameter, when fully cooled in liquid air from room temperature are given in Table II.

Expansion-Fit Allowances

The resulting stress in the parts depends upon the fit allowance. Where allowance is too great the elastic limit of the material in one or both parts is exceeded and a permanent set occurs. In extreme cases the ultimate strength of the metal is exceeded, causing a rupture. The intensity of the grip and the resistance to slippage of expansion-fits increase with thickness of parts.

TABLE II—APPROXIMATE LINEAR CONTRACTION PER INCH BETWEEN + 70 DEG. F. AND — 310 DEG. F.

	Linear Contraction per Inch, Length or Diameter, In.
Aluminum	0.0038
Brass	0.0031
Bronze	0.0038
Cast iron	0.0018
Copper	0.0029
Monel	0.0025
Nickel	0.0021
Steel	0.0020

The amount of contraction available when using liquid air for expansion fits is ordinarily less than the expansion obtainable with heat for shrink fits. Therefore, smaller fit allowances are required. The inner part, when fully cooled in liquid air, should slip easily into hole in the outer part, without forcing or driving. It should be at least a sliding fit. In such cases most of the restrained expansion of the inner part is used in intensifying the grip of the fit.

For expansion fits of 6-in. diameter and less, good results are usually obtained where fit allowances are such that inner parts, when fully cooled in liquid air, are sliding fits in holes in outer parts. Table III gives sliding-fit allowances and tolerances recommended for trial fits.

TABLE III—ALLOWANCES AND TOLERANCES FOR SLIDING FITS

Fit Diameter In.	Allowance, In. Close	Moderate
½	0.00025	to 0.0005
1	0.0005	to 0.001
2	0.001	to 0.002
3½	0.002	to 0.0035
6	0.003	to 0.005

A fit of this type is obtained by machining inner part, at room temperature, to a diameter larger than the hole in outer part, or oversize, by the amount which the inner part will contract in liquid air (determined from Table II), less the sliding-fit allowance (taken from Table III).

Example—

A brass bushing is to be expanded into a 2-in. diameter hole in a casting. To what diameter should the bushing be machined?

Solution—

Contraction per inch diameter from Table II = 0.0031 in.
Total contraction of bushing = 2 x 0.0031 = 0.0062 in.
Less sliding-fit allowance, from Table III = 0.002 in.

Amount which bushing should be oversize = 0.0042 in.
Plus diameter of hole = 2.0000 in.

Diameter to which bushing should be machined = 2.0042 in.

Where fit diameters are too small for satisfactory expansion fits, or where an unusually powerful grip of fit is specified, compound fits are sometimes employed. These are accomplished by cooling the inner part in liquid air and simultaneously heating the outer part (usually in water at boiling point, 212 deg. F.). The inner part expands as the outer part contracts, resulting in a compound effect.

As with expansion fits, the fit allowance may be such that inner parts, when fully contracted in liquid air, are sliding fits in the holes in the outer parts. The latter, however, are in this case heated to 212 deg. F. and hence expanded. Table IV gives approximate linear expansion of various metals, per inch of length or diameter, when heated from room temperature to that of boiling water.

TABLE IV—APPROXIMATE LINEAR EXPANSION PER INCH BETWEEN 70 DEG. F. AND 212 DEG. F.

	Linear Expansion per Inch, Length or Diam., In.
Aluminum	0.0018
Brass	0.0015
Bronze	0.0014
Cast iron	0.0008
Copper	0.0012
Monel metal	0.0011
Nickel	0.0010
Steel	0.0008

The diameter to which the inner part should be machined, at room temperature, for a compound fit may be determined in similar manner as for an expansion fit, but with allowance for the hole in the outer part being expanded.

Example—

A hardened steel bushing is to be compounded-fitted into a thick cast-iron pedestal, with 3½-in. diameter bore. Calculate proper diameter for bushing.

Solutions:

Expansion of hole, per inch diameter from Table IV = 0.0008 in.
Total expansion of hole = 3.5 x 0.0008 = 0.0028 in.
Plus diameter of hole at 70 deg. F. = 3.5000 in.

Diameter of hole at 212 deg. F. = 3.5028 in.
Contraction of bushing, per inch diameter (from Table II) = 0.002 in.
Contraction of bushing, total = 3.5028 x 0.002 = 0.007 in.
Less sliding fit allowance (from Table III) = 0.003 in.

Amount bushing should be oversize (in expanded hole) = 0.004 in.
Plus diameter of hole, at 212 deg. F. = 3.5028 in.

Diameter to which bushing should be machined = 3.5068 in.

Liquid Air for Breaking Fits

In some cases where inner parts are hollow or are otherwise adapted they can be immersed in liquid air or filled with it and contracted before the outer parts have cooled. Where the operation is performed rapidly, fits may be broken in this manner without the use of force.

The process of making expansion-fits with liquid air, while essentially a simple one, requires the observance of certain rules to assure best results.

1. Remove all grease, oil, etc., from parts before placing them in liquid air.
2. Thoroughly clean out working containers at regular intervals.
3. For insulation of working containers use only materials of mineral origin, such as mineral or slag wool, asbestos, infusorial earth, etc.
4. Keep combustible materials away from the working area.
5. Open flames, cigarettes, etc., are not permissible in the vicinity.
6. Replenish liquid air in working container from time to time to maintain fairly uniform level.
7. Do not allow liquid air to come in contact with skin. Avoid handling cold parts with bare hands.
8. Parts should remain in liquid long enough to cool thoroughly, ordinarily for four or five minutes. Liquid will be observed to boil violently at first, then with gradually diminishing vigor and finally, just before action ceases, again violently for a few seconds. Wait for this signal.
9. Avoid filling working containers too full and immersing excessive quantities of parts at a time; otherwise boiling over and splashing will cause wastage of liquid air.
10. Insert parts immediately upon removal from liquid. Delay will permit them to become frosted over. If they do, recool them in liquid before inserting.

Liquid air requirements and costs in making expansion-fits indicate that the process has clearly defined limitations which should govern its promotion. where conditions do not preclude the use of heat, or other considerations outweigh its advantages, ordinary shrink fits, made with heat, are more economical and will continue to be standard practice.

However, there are undoubtedly numerous fits that can be made more advantageously and economically with liquid air than with heat, and others that can be made only with liquid air, where heat cannot be used. Where parts that require heating are very large and heavy, compared to parts to be fitted into them, where heating of such parts causes cracking and warping, where outer parts have insulation, rubber, etc., attached to them which heat would damage, where furnace equipment is not available, etc., the comparative simplicity and economy of making such fits with liquid air is obvious. In fact, in this field new methods of assembly which have not heretofore been feasible may be discovered.

The various factors connected with each case, such as availability and adaptability of liquid air to operation, quality of work, rate of production, speed of operation, investment in equipment, unit costs of labor, material, etc., for liquid air and for other possible processes should be carefully considered, before definitely recommending liquid air for making expansion-fits as a production process.

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THE A.S.T.M. subcommittee in charge of wrought and cast alloys for high-temperature use is outlining a procedure for preparing cast test specimens for the tension test. This involves a study of mold construction and foundry practice necessary to insure a sound specimen.

FROM AMONG READERS' PROBLEMS

Conducted by

L. H. MORRISON

BURNING GAS IN DIESEL ENGINES—*We are operating two 500-hp. air-injection diesels, and now that natural gas is available at 15c. per 1,000 cu.ft. we wonder if it is possible to arrange the engines to burn gas instead of oil.* H.T.B.

One engine manufacturer has conducted a series of tests on this gas-diesel idea and finds that an oil engine will function satisfactorily on gas. It is necessary to change the fuel-valve lifting mechanism to permit the duration of the valve opening to be under governor control. The gas may be compressed in the air compressor to a pressure of around 800 lb. to insure sufficient gas velocity into the cylinder. A pressure-relief bypass is needed on the compressor discharge. You should take the matter up with the builder of your engines.

Many oil engines have been converted to gas engines by changing the piston to give the necessary larger clearance volume required by a spark-ignition engine. Instead of the fuel valve an igniter is placed in the cylinder head and the governor is connected to a gas-mixing valve on the intake manifold. A magneto is necessary.

ADVANTAGE OF COMBINED CO_2 AND AMMONIA REFRIGERATING SYSTEM—*Wherein is the advantage of a combination of a CO_2 and an ammonia refrigeration system for low-temperature work?* C.M.G.

To carry a low temperature, ammonia vapor has a large volume per pound, for —30 deg. F. a pound of ammonia vapor has a volume of 18.96 cu.ft. It follows, then, that the compressor cylinder becomes unduly large and the frictional losses high. Compound cylinders, with intercoolers, would be necessary to avoid excessively high discharge temperatures with such a large compression ratio. By using CO_2 for the low stage and ammonia for the high stage, the machine assembly is simpler and cheaper.

HEAT CONTENT OF STEAM—*Is it a fact that a pound of steam at any pressure and degree of superheat contains less heat than the amount shown in the steam tables for the given conditions of pressure and temperature?* E.K.

The column "Heat Content" of the steam tables actually gives the total heat that has been added to a pound of water at 32 deg. F. to bring it to the stated pressure and temperature. This heat is made up of the internal heat of the fluid plus the heat added to permit the steam to increase its volume. The volume increase is brought about by the exertion of work by the steam upon the surrounding medium and does not remain in the steam. For example, assume the boiler to be connected to an engine. The steam in forming increases its volume, and to accommodate this increase the engine's piston is forced forward. Work is done by the heat, but at no time is this heat equivalent to external work in the steam. Incidentally, in the steam engine diagram, the portion of the digram before cutoff is due to the external work of the steam, while the portion after cutoff is at the sacrifice of some of the steam's internal energy.

PREVIOUS QUESTION DISCUSSED BY READERS

THE QUESTION

WE HAVE an air compressor driven by a 125-hp., 700-r.p.m. motor through a 16-in. double leather belt. The motor pulley is 16 in. and the flywheel on the compressor 88 in. in diameter. There is an idler on the belt about halfway between the pulleys, which run on 9-ft. centers. Where is the best place to locate the idler to prevent slipping of the belt? D.J.

The horsepower transmitted by a belt is $\frac{PV}{33{,}000}$, where V is the linear velocity of the belt in feet per minute and P is the effective pull in pounds. For the case given V is 2,925 ft. per minute and the effective pull is 1,410 lb., or 88.2 lb. per inch of width. With a 16-in. pulley on the motor this is somewhat high. Good authorities recommend an average pull of 56 lb. per inch width for a double belt running over a 16-in. pulley at 3,000 ft. per minute. Since this belt is driving an air compressor, the load will not be steady, but somewhat jerky, and the effective pull will be even less than specified.

Conditions would be somewhat improved by moving the idler pulley nearer the motor. The distance from the motor pulley to the idler should be about one-quarter of the distance between shaft centers. Placing it in this position will increase the arc of contact on the motor pulley. The slack side of the belt should be on top.

A better solution would be to increase the pulleys' diameters 25 per cent. This would increase the belt speed to about 3,750 ft. per minute and decrease the necessary effective pull to a more reasonable value. Also, the internal wear of the belt would be reduced.

WALLACE H. MARTIN.
Corvallis, Ore.

TO PREVENT the belt's slipping it is essential that the arc of contact around the motor pulley be as large as possible. The best location for the idler pulley will therefore be on the slack side of the belt, as close to the motor pulley as practicable. The clearance between the faces of the two pulleys should be about one inch. The initial length of the belt should be such that it will allow an arc of contact around the motor pulley of not less than 225 deg. when the idler is tightened.

The most satisfactory mounting of the idler would be on a swinging arm, equipped with weights to give just sufficient tension to the belt to prevent slipping. Such a mounting would make the belt tightening virtually automatic. The more the belt stretches the firmer its grip on the motor pulley, due to the increased arc of contact.

Denver, Colo. J. F. RASMUSSEN.

MOVE the idler pulley as close as possible, or convenient, to the smaller pulley of the drive, and on the slack side of the belt. This holds true no matter if the smaller pulley is the driver or the driven one.

In our plant the two exciters had a drive of almost the same pulley ratios as D.J.'s, 5.5 to 1 on 9-ft. centers, one belt operated with the slack side on top and the other with bottom side slack. The belts were 5-in. double-leather,

and gave a great deal of trouble for their first five years of service. All kinds of cures were tried, and rejected for good reasons. About a year ago an idler pulley was installed on each drive, made from surplus material and some blacksmith work. The double belts, having been ruined in trying to make the drives work, were replaced with single belts. A considerable amount of experimenting finally convinced us that a drive of this nature should conform to the following rules:

1. The idler pulley should be of slightly larger diameter than the smaller pulley of the drive, and could have a slight crown.

2. The idler pulley should be fairly heavy, with a correspondingly heavy counterweight, to minimize bounce caused by fluctuating loads, etc.

3. Means should be provided for balancing the idler so that it will bear on the belt with only enough weight to prevent slipping, as the idler should only float on the belt.

By following these simple rules our exciter drives are giving no trouble, and the belts run with unbelievably little slack. THOMAS C. HULTON.

Abras Grandes, Cuba.

IT APPEARS correct to assume that the compressor will run with the top half of the driving shaft turning toward the cylinder. This means a tight belt on the bottom, and the idler on the top; also that a horizontal line will pass through the centers of the two pulleys.

The normal position for an idler pulley is where the belt on each side of it is at the same angle to the horizontal, this being the normal position for it to come to rest. On the other hand, where it becomes necessary to develop as much contact as possible on the driving pulley to prevent slippage, as in the present case, the idler can be placed so that the belt leading to it is at 30 deg. to the vertical, and the bottom of the idler pulley is located one inch from the tight side of the belt. In D.J.'s installation this will give about 30 per cent increase in driving pulley contact.

Unfortunately, this belt is good for but 90 hp. normal duty, and becomes overloaded if 125 hp. is required to drive the compressor.

ROLAND A. PACKARD,
Plant Engineer,
Lee, Mass. Smith Paper Company.

THERE are many practical idler drives available to solve the problem of slipping belts. The pulley ratio and the belt speed combined with the short distance between centers in the problem are no different from many other installations successfully handled by drives already on the market.

To prevent slip of short-centers, on belts with pulley ratios like those in the question the arc of belt contact on the small pulley must be more than 60 per cent of its circumference. To accomplish this it is necessary that the idler pulley swing in an arc conforming to the small pulley. Alignment in a drive of this kind is important, and equipment on the market provides for it.

These drives are illustrated and described in almost all engineering catalogs, and D.J. would do well to investigate some of them before committing himself to any shop-made arrangement. W. F. O'REGAN.

Boston, Mass.

THE PROPER location for the idler is as close to the driving pulley as possible, and it should wrap the belt around the pulley sufficiently to give an arc of contact of at least 225 deg. Applying the idler close to the driving pulley and bringing the slack side of the belt down to within 4 to 6 in. of the tight side will give a contact of about 225 deg., and should correct D.J.'s trouble, if other conditions are correct. In the event it does not, then the following may help:

Steel pulleys are not advisable for this type of drive, unles well lagged. Use a good composition pulley with slight crown. Check the motor to see that all electrical connections are tight and the bearings are in good condition. If a slip-ring motor is used, check rings and brushes to see that good contact is obtained. Sometimes loose connections or poor brush contact will cause the motor to surge, which, in turn, will cause belt slip.

Keep the pulley, belt and flywheel clean. If the belt is working in dry, dusty atmosphere, brush the pulley side lightly with a wire brush and dress with neats-foot oil, used sparingly.

If the belt is in a hot, moist or oily atmosphere, scrape and wash the driving surface with gasoline or some other solvent that will evaporate quickly, then brush lightly with a wire brush. This is done to loosen the fibers to present a better gripping surface to the pulleys.

Avoid sticky belt dressings as much as possible, and keep driving and driven pulleys in correct alignment. Incorrect alignment will create tension in one edge of the belt and cause it to wobble and slip. If properly spliced and applied, and occasionally cleaned, good quality leather belts should last indefinitely. WILLIAM C. JONES.

Provo, Utah.

ACCORDING to the best authorities, a belt will only pull a certain load per inch of width without slipping, no matter how tight the idler is made, or its position. The arc of contact of the belt on the pulley is also to be taken into consideration. Below are tabulated the results of tests on pulls of belts without slipping for different arcs of contact, for double belts with smooth joints.

Arc of Contact, Degrees	Allowable Effective Pull, Lb. Per In. of Width
90	33.3
120	41.1
135	44.7
150	48.3
160	51.0
180	54.4

The horsepower which can be transmitted by the belt, assuming an arc of contact of 140 deg. without the idler, would be:

$$\frac{\textit{Belt speed} \times \textit{Belt width} \times \textit{Effective pull}}{33{,}000}$$

$$\frac{2{,}848 \times 16 \times 45.6}{33{,}000} = 60.20$$

Even with an idler to increase the arc of contact to over 180 deg. the power of the belt is below that needed for the motor. I should therefore recommend that either a larger belt be used or a multiple-rope drive be substituted:

If it is found impossible either to install a wider leather belt or to substitute a rope drive, the idler should be placed as near to the driving pulley as practicable and the belt should be cleaned thoroughly and proper dressing applied. When this is done slipping may not be overcome entirely, as there may be periods when the compressor is loaded to capacity, causing the belt to slip. GEORGE I. WILSON.

Kapiskasing, Ont.

A Question for Our Readers

IN OPERATING an automatic stop and check valve on a boiler we screw down the stem on the valve as a precautionary measure before sending a man in the drum, but leave open the valve next to the main header. After the cleaning is completed and the boiler is being prepared for firing, we raise the valve stem and allow the boiler to come on the line automatically. Is there anything wrong with this practice? G.R.J.

Suitable answers, if received promptly, will be paid for[1] when published

[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.):

Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fritz' *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Annett's *Electric Elevators.*

THE ENGINEER'S B

Heat Power Machinery

STEAM POWER AND INTERNAL COMBUSTION ENGINES. *By Dudley P. Craig and Herbert J. Anderson, both of the mechanical engineering department at Purdue University. Published by McGraw-Hill Book Company, 330 West 42nd St., New York City; 1931. Cloth, 6x9 in.; 482 pages, 306 illustrations. Price $4.*

THE TITLE chosen for this book seems unfortunate in that it misleads the reader into expecting more material on internal combustion engines than contained in the single chapter of 55 pages. The book, however, is an excellent text on the fundamental principles underlying heat power machinery and is intended primarily for engineering students. The subject matter includes descriptions of up-to-date power plant equipment, expositions of theory underlying its construction, operation and methods of adapting it to power units.

For this type book the chapters on feed-water treatment, turbines, steam engines and pumps are rather better than usual.

There occur in the text statements that may be open to question. For example, in the discussion of boilers the authors state that pressures of 600 and 700 lb. per sq.in. are quite common. Relatively few plants operate in this pressure range because the cost of necessary reheat equipment is not generally justified by the thermal economy. Pressures of 400 to 500 lb. have become popular in plant design and mark the upper pressure limit that is used without reheat. This limit will, of course, be raised as temperatures increase.

Again in calculating the heat loss due to moisture in fuel and that formed by combustion the authors use formulas of the same type as that given by the A.S.M.E. boiler test codes but with different constants. In this case the authors have apparently failed to recognize that the pressure of the vapor in flue gas is considerably below atmospheric and used the value 970.2 as its latent heat. These discrepancies are of minor importance and do not detract from the value of the book as power plant text.

Structural Welding

REPORT OF STRUCTURAL STEEL WELDING COMMITTEE OF THE AMERICAN BUREAU OF WELDING. *Published by the American Welding Society, 33 West 39th St., New York City; 1931. Paper, 6x9 in.; 208 pages; diagrams, charts, tables and photographs. Price, $1.*

THE AMERICAN BUREAU OF WELDING is part of the American Welding Society—the part particularly devoted to research. In 1926 the Structural Steel Welding Committee of the bureau was organized for the purpose of "obtaining reliable information upon which to base safe unit working stresses in the designing of welded structures." In short, this committee proposed to do the essential pioneer work, without which few would care to apply welding to steel structures. This committee has continuously had the services of some of the best structural engineers in America. More than $20,000 has been contributed to its work.

Participants in the investigation controlled by this committee included three steel mills, 39 fabricating shops, 61 welders, 18 inspectors and 24 testing laboratories. About five years was spent on the entire investigation. The final conclusion of the report is that the following unit stresses in thousands of pounds per square inch of weld throat are safe and reasonable, provided the welder has been qualified and provision has been made for bending stresses that may be introduced by eccentricity:

Shear	11.3
Tension	13.0
Compression	15.0

The importance of this publication to structural engineers is beyond calculation. Many power engineers whose work occasionally involves structural extensions or alterations, will find this book of value for reference purposes.

Plastic Flow in Metals

PLASTICITY: A Mechanics of the Plastic State of Matter. *By Dr.-Ing. A. Nádai assisted by A. M. Wahl, both of the Research Laboratories of the Westinghouse Electric & Manufacturing Company. Published as the first of the Engineering Societies Monographs by the McGraw-Hill Book Company, 330 West 42nd St., New York City; 1931. Cloth, 6x9 in.; 350 pages, illustrated. Price, $5.*

FIRST of the series to be issued by the Engineering Societies Monographs Committee of the four Founder Societies—American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers—this book presents the fundamentals of the theory of plastic flow in materials, especially in metals. It is concerned with one important part of the theory of strength of materials and is grounded on the best methods of engineering mechanics, as well as on the latest results of laboratory tests.

Based on the original German edition, but amplified and enlarged by the addition of new information, the book brings together the observations of engineers, metallurgists and physicists regarding the plastic deformations of metals and then summarizes the laws, which in the present state of knowledge are available, for the more exact prediction of the distribution of stress. The first part of the book deals with the plastic state of matter in connection with metals and mechanical engineering problems, while the second part is devoted to some of the applications of plastic theory to geology and geophysics.

The book embodies the author's experiences of nearly ten years at the Institute of Applied Mechanics of the University of Göttingen, where applied sciences under Felix Klein and L. Prandtl have been so highly developed. In addition it contains the results of much of Dr. Nádai's recent work in his connection with the Westinghouse Research Laboratories.

Heat Accumulator Stress

WÄRMESPANNUNGEN IN GLEICHDRUCK-WÄRMESPEICHERN (HEAT STRESSES IN CONSTANT-PRESSURE HEAT ACCUMULATORS). *By Dr.-Ing. E. Mayer. Published as Forschungsheft 346 by the VDI-Verlag, Dorotheenstr. 40, Berlin NW 7, Germany; 1931. Paper, 8x12 in.; 23 pages, charts and diagrams. Price, 5 marks.*

CONSTANT-PRESSURE heat accumulators are of late being installed in steam power plants at an increasing rate. The difference between the heat in the feed-water at boiling point, corresponding to the boiler working pressure, and at the temperature of the condensate is utilized for the accumulation of heat. The heat-storing capacity of an accumulator of a given size depends upon the temperature difference between the hot and cold water. It is therefore of importance to know how far the difference in temperature can be carried without endangering the safety of the accumulator. In design the heat stresses must not be disregarded, and it is necessary to determine at the outset how far they require consideration in the choice of the temperature difference.

The magnitude of the heat stresses has been determined by the author both by test and by mathematical considerations. The changes of temperature and strain from the hot to the cold part of the wall, as established by test, are more abrupt when the accumulator is at rest than during the working periods. For ascertaining the maximum stresses due to the temperature difference, therefore, the state of rest has to be considered. Furthermore, it is seen that strains

BOOKSHELF

calculated on the assumption of a sudden jump in the temperatures in the tank wall are much higher than those ascertained by test.

The distribution of the temperature can be determined analytically by means of exponential functions both for the case that the working conditions change with the time and that they remain constant; these functions have to be introduced as particular solutions into the differential equations for the strains.

The investigations show that the bending stresses (in axial direction) exceed the circumferential stresses if small surface coefficients of heat transfer are to be considered. Under these circumstances the influence of the heat stresses upon the total stress in the material is somewhat less.

Analytical Mechanics

ANALYTICAL MECHANICS. *Third Edition. By H. M. Dadourian, Seabury professor of Mathematics, Trinity College. Published by the D. Van Nostrand Company, 250 Fourth Ave., New York City; 1931. Cloth, 6x9 in.; 427 pages, illustrated. Price $4.*

AS ITS TITLE SUGGESTS, a textbook on analytical mechanics should have two definite objectives, the first being that of imparting a fundamental groundwork of general mechanics. Such a foundation necessarily forms the basis of an intelligent approach to those technical subjects which are more directly applicable to the solution of engineering problems. The second objective should be the development of, and practice in, the analytical method of thought.

This book admirably meets both these objectives. The various principles of mechanics are progressively introduced and logically developed, care being taken that the concepts presented are not lost in a maze of rules and formulas.

Early in the book the author presents the fundamental principle on which the science of mechanics is based. This he calls the *action principle.* The use of this as the basis for the development of the subject is perhaps the outstanding reason for the book's value as a textbook. Since this principle emphasizes only the forces to which the particular body being studied is subjected, the readers' mind need not be confused by interactions and internal forces not pertinent to the analysis. It lends itself easily to the logical presentation and gradual development of the subject. Thus the reader is led onward from the simpler theorums of equilibrium to the more complex dynamical concepts of motion acquiring experience in the use of the required mathematics and proficiency in the analytical method as he progresses.

The first five chapters are devoted to the mechanics of equilibrium, the fifth being a very interesting one on the equilibrium of flexible cords. The remaining eleven chapters comprehensively cover the mechanics of motion. Throughout the book many illustrative examples are given to demonstrate the application of the various principles as they are presented. In addition, the author presents twelve general directions for the solution of problems with a minimum of mental effort.

Thus the book is complete as a text and is also valuable as a reference for the engineer who needs to refresh his memory on some phase of mechanics.

Elevator Safety Code

AMERICAN STANDARD: SAFETY CODE FOR ELEVATORS, DUMBWAITERS AND ESCULATORS. *1931 Edition. Published by the American Standards Association, 33 West 39th St., New York City. Cloth, 5½x8 in.; 173 pages. Price, $1.*

DEVELOPED under the technical direction of the American Society of Mechanical Engineers, the American Institute of Architects and the United States Bureau of Standards, this code gives rules for the construction, inspection, maintenance and operation of elevating equipment. It is intended as a guide to state and municipal authorities in the drafting of their regulations. It is also intended as a standard reference on safety requirements for the use of elevator manufacturers, architects and consulting engineers and as a standard of practice for elevator buildings.

This edition follows quite closely the form and arrangement of the second, although considerable new material has been added, particularly under definitions and the various sections covering safeties, terminal stopping devices, buffers and interlocks.

BRIEF REVIEWS

SOME CONSIDERATIONS AFFECTING THE FUTURE DEVELOPMENT OF THE STEAM CYCLE. By K. Baumann. Published by the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, England; 92 pages, illustrated.—A study of some of the factors which affect and limit the trend toward higher steam pressures and temperatures in modern power stations.

MEMORANDUM BY ENGINEER-IN-CHIEF, 1930. Published by the Manchester Steam Users' Association, 20 Quay St., Deansgate, Manchester, England; 70 pages, illustrated.—This is the annual engineering report of the Manchester association, founded for the prevention of steam boiler explosions and the attainment of economy in steam applications. The report covers various boiler failures that occurred during the year and describes the behaviour of steel at high temperatures.

VOLTAGE RELATIONS AND LOSSES IN SMALL UNIVERSAL MOTORS. By A. F. Puchstein and I. S. Campbell. Published as Bulletin No. 58 of the Engineering Experiment Station, Ohio State University, Columbus, Ohio; 28 pages, illustrated; price 50c.—Results of performance tests on universal motors ranging from 1/75 to ⅛ horsepower.

RECENT DEVELOPMENTS IN THE THEORY, DESIGN AND MANUFACTURE OF HEAT EXCHANGERS AND RESEARCH ON THE HEAT TRANSFER COEFFICIENTS FOR PETROLEUM OILS AND OTHER FLUIDS. Published as Bulletin No. 350 by the Ross Heater & Manufacturing Company, Buffalo, N. Y.; 106 pages, illustrated.—A collection of pages presented by engineers of the Ross company at a heat exchanger conference held by the company in Buffalo last April.

TESTS OF WELDS. By Wilbur M. Wilson. Published as Circular No. 21 of the Engineering Experiment Station, University of Illinois, Urbana, Ill.; 37 pages, illustrated; price 20c. Report of an investigation into the hand-welding of relatively thin steel plates used in the fabrication of storage tanks for oil and water systems.

HEAT TRANSFER IN A COMMERCIAL HEAT EXCHANGER. By B. E. Short and M. M. Heller. Published as Bulletin No. 3128 by the University of Texas, Austin, Tex.; 48 pages, illustrated. Results of tests made on a horizontal shell-and-tube type heat exchanger having a heating surface of approximately 20 sq.ft. and using heated fluids with viscosities of from 0.44 to 40 centipoises.

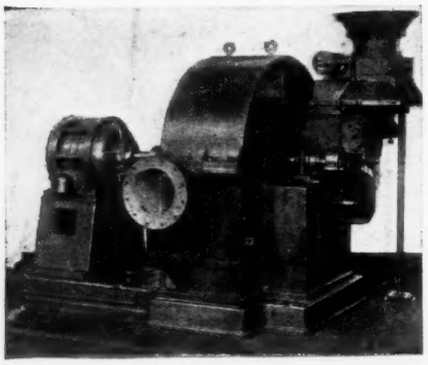
VON DER WERKSTATT ZUR WERKSTADT; 58 pages, illustrated; price 7 marks. DER SIEMENSKONZERN IM BILDE; 200 pages, illustrated; price 7.5 marks. For sale by the V.D.I.-Verlag, Dorotheenstrasse 40, Berlin N.W. 7, Germany. The first book gives in broad outline an account of the rapid expansion of the Siemens concern, which is one of the largest electrical companies in the world. The second book contains a collection of photographs illustrating the work and plant equipment of this vast enterprise.

WHAT'S NEW IN PLANT EQUIPMENT

Improved Unit Pulverizer

BETTER FINENESS, increased capacity and lower power consumption per unit of output are claimed for the improved design of Atrita pulverizer recently introduced by the Riley Stoker Corporation, Worcester, Mass.

In the new design the grinding chamber housing and fan chamber housing, which were previously made separate, are combined in one common housing. This change has decreased the over-all width of the machine about 8 in. The housings have also been changed to all-welded steel construction from cast iron.



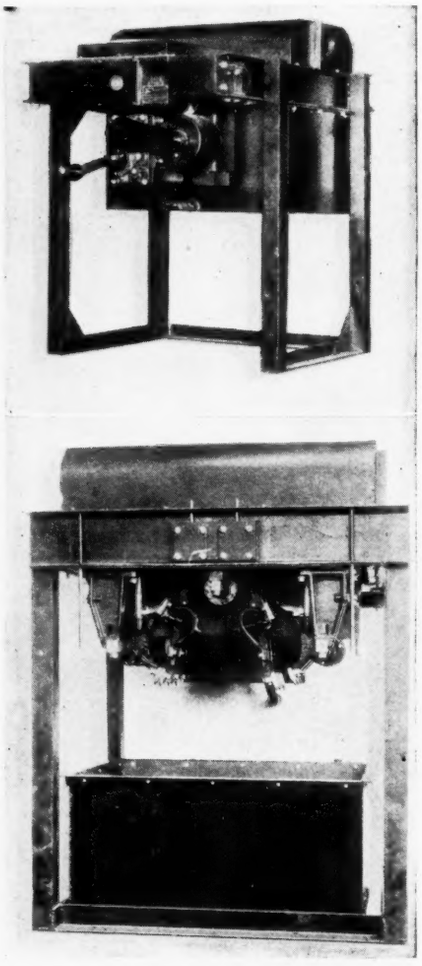
Pulverizer with combined grinding and fan housings

Transfer Switch for Two-Speed Fan Motors

TWO-SPEED squirrel-cage induction motors are frequently used for boiler fans, and required some form of transfer switch. This switch is a simple double-throw device for a two-speed motor or a two-motor combination, but becomes more complicated when more than two-speed combinations are used. The figures show a two-speed oil-immersed selector switch developed by Cutler-Hammer, Inc., Milwaukee, Wis., for large two-speed fan motors 300- to 500-hp. at 2,300 volts, of the induction type. It is of three-pole double-throw design, with three positions: low speed, high speed and off, and following in that sequence, that is, there is no off point below low and high when accelerating. When changing from high speed to low speed the transition is under control of a speed governor, which prevents low-speed connection until the motor has slowed down.

This switch is cam-actuated, mounted on anti-friction bearings, and driven by a $\frac{1}{4}$-hp. direct-current motor. No attempt is made to stop the cam accurately at a given point, it being allowed to come to rest against dynamic braking of the motor. Dynamic braking is secured on the compound driving motor without additional contactor parts by connecting the braking resistor permanently across the armature.

A switch of this type must withstand frequent operation, such as encountered with automatic combustion control. For a 500-hp., 2,300-volt motor, a 600-amp. switch mechanism capable of carrying a 20 per cent overload continuously is employed. No overload device is provided, as the switch is not intended to interrupt high values of current in normal operation. It is designed as a transfer switch to be installed with a circuit breaker for handling overload or short circuits.



Oil-immersed three-pole double-throw transfer switch assembled and with oil tank removed

A truck for lowering the oil tank is provided. It can be operated from either side, and in close quarters. The platform is mounted on roller swivel casters which permit withdrawal and movement of the tank in a narrow aisle, and without turning.

Manual operation is provided for from a detachable handle. Rotation of this handle through slightly more than one revolution will move the switch from any position to an adjacent position. A position indicator is provided to the right of the manually operated shaft. Transferring from automatic to manual operation is done by disengaging a small lock pin and pulling out on the manual drive shaft. The mechanism is put back on the motor drive by pushing this shaft in, and it is then locked in place by the same pin. This mechanism can also be provided in a slightly different form so that it will spring back into engagement and lock automatically.

Similar switches have been made in the air-break form for 440-volt service, carrying additional contacts for reconnected motors, and for the secondary or rotor circuits, where required.

Turbine Bleeder Line Non-Return Valve

THE automatic non-return valve for use on turbine bleeder lines now being manufactured by the Davis Regulator Company, Chicago, Ill., is of the lift-disk type, with secondary oil cylinder control. The disk is free to close when a back flow of any kind occurs. In addition to this a positive means of closing is provided by an oil power cylinder mounted on the valve cover either above or below the valve. This cylinder is connected to the turbine lubricating system. The oil pressure holds the piston compressed against tension springs under

Davis non-return valve for bleeder lines

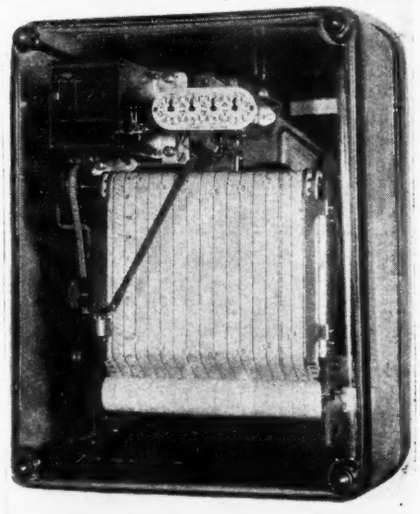
normal operating conditions. When the trip mechanism connected to the turbine throttle valve operates, the oil pressure is released and the springs force the piston stem directly on the valve stem and seat the disk.

The valve is made in sizes ranging from 2 to 24 in. of steel, semi-steel or cast-iron and trimmed for saturated or superheated steam.

Recording Demand Watt-hour Meter

TYPE RB recording-demand watt-hour meter illustrated indicates on a four-counter dial the total kilowatt-hours consumed, and records on a chart the integrated demand in kilowatts over successive, predetermined intervals.

This meter consists of a watt-hour meter register containing gears for driving the four integrating counters and causing the pen to advance across the chart a distance proportional to the kilowatt-hours consumed during the interval for which the meter is set. At



Type RB recording demand meter

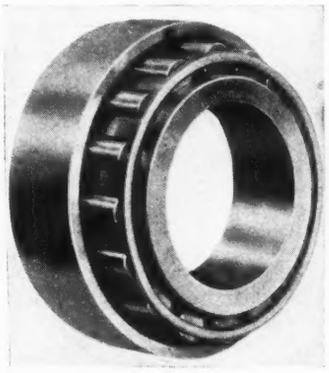
the end of this interval the pen is automatically released from the driving mechanism and swings back to the zero position, where it is again meshed with the gear train ready to advance during the next interval. Just before the pen is released from its maximum position the record paper is advanced a fraction of an inch, assuring a distinct record of maximum pen travel.

In this manner a record of kilowatt demand taken at periods of desired length (usually between 5 and 60 min.) is obtained.

The complete meter is fastened to a one-piece, cast-iron frame so that the element may be removed from the base without disturbing the calibration or the relative position of any of the meter's parts. The meter is put out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Radial Roller Bearings

HIGH load-carrying capacity, low friction, quiet running characteristics and minimum space for a given load are claimed for a line of roller bearings now being put out by the Aetna Ball Bearing Manufacturing Company, Chicago, Ill. The line includes CR-200, CR-300 and



Aetna roller bearing

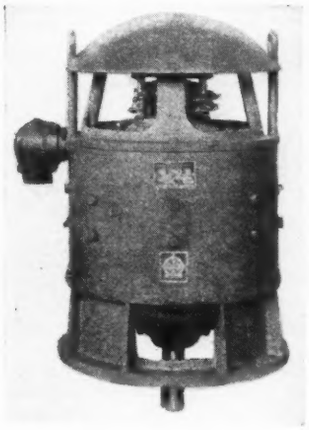
CR-400 series for light, medium and heavy duty, comprising 64 bearings ranging from $1\frac{3}{16}$ to $10\frac{7}{16}$ in. in outside diameter.

The bearings are standardized and interchangeable with other makes and types of bearings as to inside and outside diameters. The outer race is free from lips or shoulders, but the inner race has a double lip. This construction permits the rollers to move longitudinally across the face of the outer race, thus providing for expansion and contraction of the shaft without cramping. Bearings equipped with either steel or brass cages can be furnished.

Direct-Current Vertical Motors

DIRECT-CURRENT motors, Type T, for vertical operation in sizes up to 50-hp. have been developed by the Reliance Electric & Engineering Company, Cleveland, Ohio.

The motors are provided with a ring base for mounting and a drip cover to protect them from falling dirt and chips, dripping water, oil or other injurious solutions.

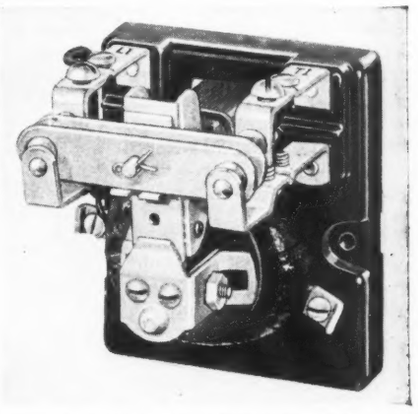


Reliance vertical motor

Where it is desirable, the motor can be mounted directly on the machine being driven, without the ring base, and made to appear as an integral part of the machine. Amply large bearings are used to take the thrust and radial loads. In all other respects the construction is the same as the Type T, direct-current, heavy-duty motor for horizontal operation.

Normally Closed and Up-and-Down Contactors

RECENT ADDITIONS to the line of contactors put out by the Allen-Bradley Company, 1311 South First St., Milwaukee, Wis., are Bulletin 201 Form D (direct current) and Bulletin 701 Form D (alternating current) contactors. These contactors are provided with "down" or "back" contacts, against which a single-pole contactor arm is held when the operating coil is not energized. When the coil is energized the circuit is opened.



Contactor for alternating and direct current

Bulletin 201 Form C and Bulletin 201 Form E contactors also available are two-wire, single-pole units. They are provided with a double set of single-pole stationary contacts and a double contactor. The two circuits are insulated from each other, one being normally closed, the other open.

Improved Test Clamps

A COMPLETE line of test clamps, designated "Kliplok," has recently been introduced by the Trico Fuse Manufacturing Company, Milwaukee, Wis. These clamps have been especially designed for testing work, although they can be used for general applications, such as making temporary connections, signaling testing, meter and motor testing and other shop tests. The jaws are actuated by the turning of a knob. All metal parts are cadmium-plated.

NEWS of the FIELD

New 200,000-Kw. Steam Station Planned for Washington, D. C., by Potomac Electric Co.

DUE TO THE steady increase in power consumption in its territory, the Potomac Electric Power Company of Washington, D. C., is considering plans for the construction of a new power plant. Officials of the company have decided that it would not be practicable to install any more additional units at the Benning plant. The capacity of the Benning plant has gradually been increased to a maximum of 208,000 kw. A 30,000-kw. unit has just been added to this plant. It is believed that any further increase in power would require more condensation water than is readily available at the location.

Subject to the approval of the authorities, the company has tentatively selected a location for a new plant at Buzzard Point in southwest Washington near the confluence of the Anacostia and Potomac rivers. It is understood that the new plant will have an ultimate capacity of 200,000 kw. with an initial installation of between 35,000 and 50,000 kw. An engineering firm will be engaged to make a survey of the situtation.

In addition to supplying adequate facilities for future growth, the Buzzard Point location will make it possible for coal to be obtained by barge. If engineers of the company become convinced that the present low prices of fuel oil will remain fairly constant, it may be decided to utilize oil instead of coal for the production of power. Fuel oil cannot be transported by barge to the Benning plant due to the fact that the river becomes shallow at that point.

Large Steam-Turbine Driven Airplane Soon to Be Tested

THE STRONGHOLD of internal combustion may switch in part to steam. Future large aircraft — transports, bombers, big commercial planes—may soon fly through the air with no noise but the beat of the propeller, according to a recent announcement of the Great Lakes Aircraft Corporation of Cleveland.

Within a few months that company will make flight tests on a plane driven by a steam turbine with a reduction gear between the turbine and the propeller. If it works, and the Great Lakes engineers after two years' study seem confident that it will, a process of refinement will be undertaken aimed at making it the standard engine for larger aircraft. At present no development in the small sizes will be undertaken.

The boiler in the new plane will be of the multiple water-tube, quick-steaming type, operating at 1,000 lb. pressure and fired by ordinary fuel oil. Condensers will be placed in the wings and, it is expected, will have sufficient capacity to reduce the water supply to 25 gal. in the 2,350-hp. plant. The turbine will be of the impulse type, expanding in three stages. Its high speed will be brought down to propeller speed through special spur gearing.

Use of fuel oil rather than gasoline will bring about some economy of operation. But the greatest economy is expected in the item of maintenance. That is of enormous size in larger planes, the DO-X being an extreme example. This giant has twelve engines of twelve cylinders each; each cylinder has four valves. Anybody who drives an automobile can picture for himself the appalling cost of valve grinding, carbon cleaning, piston and ring replacement, not to speak of electrical maintenance. All this will be eliminated in the steam plant. While a turbine will not run forever, it is expected that the plant will require only minor adjustments for at least three years of normal operation.

Data on the vital matter of weight per horsepower is not now available. Some lightness had to be sacrificed in order to use devices of successful performance records. However, Great Lakes engineers believe that the first plant will be little if any heavier than gasoline engines of equal power, and that eventually they will produce them lighter.

St. Lawrence Power Hearings Postponed

PUBLIC HEARINGS scheduled by the New York State Power Authority to begin Oct. 1, as the first step in the plans to arrive at terms for contracts to be negotiated with private companies for the disposition of St. Lawrence power, have been postponed until Nov. 2, according to announcement by Chairman Frank P. Walsh.

The Power Authority took up the replies received from electrical companies throughout the state to question-

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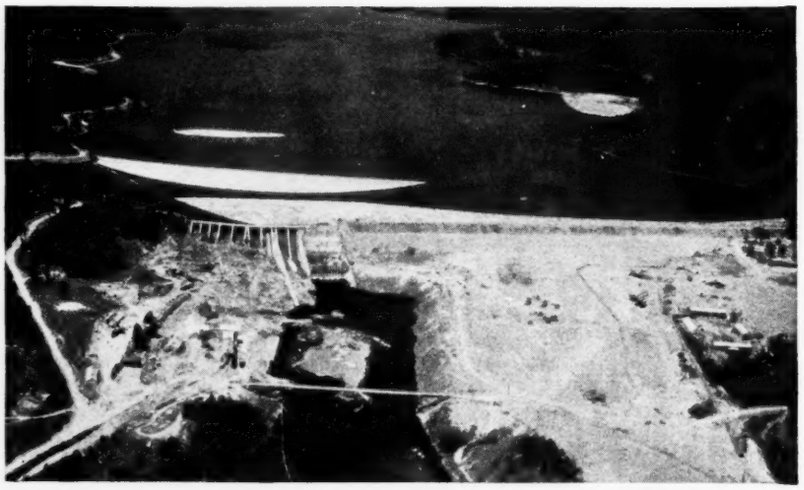
WYMAN DAM NEARS COMPLETION



Finishing touches are being put on the Central Maine Power Company's new Wyman Dam plant located on the Kennebec River at Bingham, Me. Two of the three 34,000-hp. generating units are now installed and in use. Wyman Dam is largely an earth-fill structure with a concrete core wall. It is 2,800 ft. long and 135 ft. high, forming a lake three quarters of a mile wide and twelve miles long

naires sent out during the summer, he said, but many of these replies were delayed, with a considerable number still outstanding. Others received were incomplete along certain lines pertinent to the Authority's study.

Examination of these replies was announced as one of the main purposes of the public hearings scheduled to begin Oct. 1, as a basis for arriving at fair terms for the contracts to be negotiated with private companies for the disposition of St. Lawrence power.

The Power Authority is now holding conferences with representatives of the companies to see whether more complete data are not available.

A.S.T.M. Approves Five Tentative Pipe Standards

COMMITTEE E-10 on Standards of the American Society for Testing Materials recently approved five new tentative specifications for steel and wrought-iron pipe, submitted by Committee A-1 on Steel. These include specifications for electric-fusion-welded steel pipe, electric-resistance-welded steel pipe, forge-welded steel pipe, lock-bar steel pipe, and riveted steel and wrought-iron pipe.

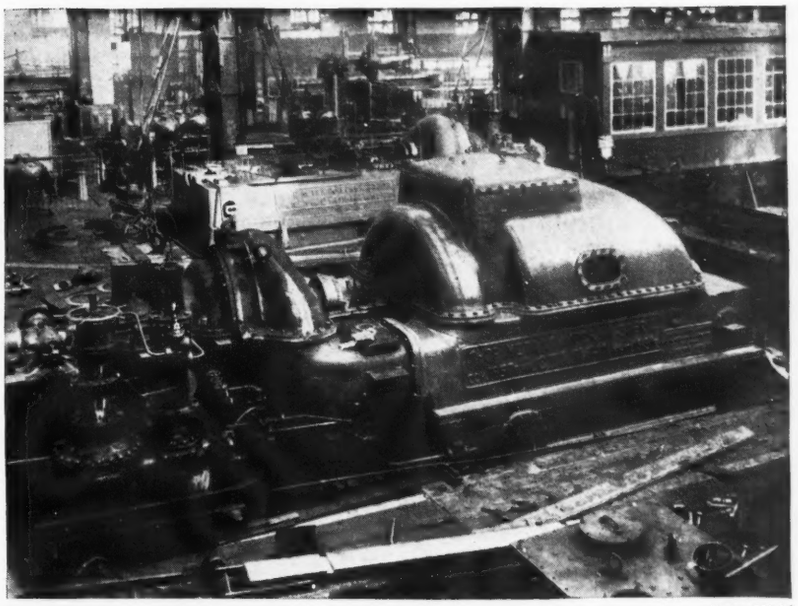
In announcing the new tentative standards, the A.S.T.M. states that the specifications for electric-resistance-welded steel pipe represent a new type of manufacture during the past two years. The specifications for fusion-welded steel pipe also represent a new product which is largely coming into use. The specifications for forge-welded steel pipe and lock-bar steel pipe are new specifications for a standard product. The specifications for riveted steel and wrought-iron pipe have been referred to Committee A-2 on Wrought Iron which will present certain revisions as applied to riveted wrought-iron pipe, but which has no objection to their adoption as tentative, subject to later revision.

Second Welding Conference At Wisconsin U., Oct. 8-10

PROGRAM has just been announced for the Second Welding Conference to be held at the University of Wisconsin, Madison, Wis., on Oct. 8 to 10 inclusive. Five technical sessions are scheduled, together with the usual quota of entertainment. A special feature of the conference will be "open house" at the mechanical engineering building on Friday night, when special demonstrations and exhibits of welding will be held.

Included among the papers to be presented are: "The Present Status and the Future of the Science and Art of Welding" (speaker to be announced); "Some Theoretical Aspects of Welding With Electricity," K. L. Hansen; "Lindewelding—A New Technique of Pipe Welding," Fred Outcault; "Use of Welding in the Fields of Plumbing and Heating," Fred Outcault; and "The Welding of Bronze and Copper by the Electric Arc Method," W. C. Swift. At the session on testing of welded joints, two papers will be given, one by Claude Gordon on "The X-Ray Method" and the other on "The Stethoscopic Method."

SOVIET TURBINE PLANT EXCEEDS PLAN



Press Cliché

The Stalin turbine plant in Leningrad, Russia, has just completed its doubled five-year plan by producing generating units totaling 420,000 kw. Originally, the largest condensating turbine called for under the plan was 10,000 kw. by 1933. But already this plant has begun the production of its second 50,000-kw. turbine and is expected to produce a 75,000-kw. unit in 1932 and a 150,000-kw. unit in 1933. One of the new 24,000-kw. turbine-generators is shown in the illustration

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75,000-Kva. Synchronous Condenser for Chicago

WESTINGHOUSE Electric and Manufacturing Company has received an order for the largest synchronous condenser ever sold, according to Westinghouse engineers, who say that the machine will exceed by 50 per cent the capacity of any existing synchronous condenser. It has been purchased by the Commonwealth Edison Company of Chicago for use in the Crawford Avenue Station.

When installed, the condenser with its auxiliaries will be 45 ft. long, 20 ft. wide and will weigh 400 tons. The condenser will have a rating of 75,000 kva. at 514 r.p.m., and the cost of the complete unit will be approximately $250,000. The auxiliaries consist of a direct-connected starting motor and high-speed excitation equipment. The machine is to provide the voltage and power factor regulation necessary to obtain the maximum capacity of a 220-kv. transmission line.

Seek License for Project On Kanawha River, W. Va.

AT A CONFERENCE with the Federal Power Commission Sept. 29, Graham Claytor, F. W. Scheidenhelm, and C. M. Micou, presented an application for a power license on the Kanawha River in West Virginia. The applicant company is the Kanawha Valley Power Company of Charleston, W. Va., a newly incorporated company affiliated with the Appalachian Electric Power Company and the American Gas & Electric Company.

This major project embraces two power plants to be located at two United States Government navigation dams. The upper of these new dams, which will replace four existing low dams, is located near London, W. Va., about 23 miles above Charleston, and the other is located at Marmet, about 8 miles above Charleston.

The proposed development contemplates the full utilization of water-power available at government dams. The primary power capacity of the project, including both plants, is about 11,000 hp. and the proposed initial installation is 38,000 hp. Each of the new plants will utilize a head of about 23 ft. with substantially the same flow, and with three units in each plant. It is expected that the entire output from this project will be sold to the Appalachian Electric Power Company to be distributed in West Virginia through the transmission system of that

company, making an important addition to the state's supply of electric energy. This project will cost about $5,000,000, and its construction will proceed as fast as the government work on the two dams will permit.

Second Group of Business Men Visits Laboratories

FOR THE SECOND TIME within a year, a group of business men and banking executives are visiting research laboratories under the sponsorship of the National Research Council. As on the first tour, many of the laboratories scheduled for visits from Oct. 5 to 15 are those maintained by large industrial organizations, while others are fostered by research institutions, in which scientific investigation is carried on in behalf of industries, both small and large.

One of the objectives of the present tour, it is stated, is to show business men and bankers the value of research to the smaller type of industrial concern, and to this end institutions engaged in such work for smaller industries will be visited.

Research departments of large industries on the tour program are those of the Eastman Kodak Company, Ford Motor Company, General Electric Company's Nela Park Lighting Institute, Basic Science Research Laboratory identified with the General Foods Corporation, Proctor & Gamble Manufacturing Company and the Westinghouse Electric & Manufacturing Company.

Other organizations on the itinerary are Massachusetts Institute of Technology, Arthur D. Little, Inc., Dewey & Almy Chemical Company, United Drug Company, Thompson & Lichtner Company, the Tanners' Council of America and the Battelle Memorial Institute.

Plan Second 132-Kv. Line From Bagnell Dam Plant

STONE & WEBSTER Engineering Corporation has been authorized by L. H. Egan, president of the Union Electric Light & Power Company at St. Louis, Mo., to proceed with the design and and construction of a second 132,000-volt transmission line extending from the 172,000-hp. Bagnell Dam hydroelectric plant, now nearing completion in Central Missouri, to the Page Avenue substation in St. Louis. This additional line will be 136 miles long and will transmit energy from the Bagnell project to the power company's system. Except for steel towers at river and highway crossings and along railroad rights-of-way the line will be built of standard H-frame wood construction along the right-of-way of the first Osage-Page Avenue transmission line. The estimated cost of the additional work is approximately $1,000,000.

COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Kansas City, Mo., Oct. 22-24. Annual winter convention in New York City, Jan. 25-29, 1932. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Refractories Institute. Fall meeting at the Hotel Cleveland, Cleveland, Ohio, Oct. 8-9. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6, 1932. Secretary, Beekman C. Little, 29 West 39th St., New York City.

National Association Practical Refrigerating Engineers. Annual convention and exhibition at the Municipal Auditorium, Houston, Tex., Nov. 10-13. Secretary, Edward H. Fox, 435 North Waller Ave., Chicago, Ill.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Obituary

COL. EDWARD ALFRED SIMMONS, president of the Simmons-Boardman Publishing Company, New York City, died Oct. 1 at his home in Brooklyn. Colonel Simmons was born in Brooklyn on March 20, 1875, and received his early education in the public schools of that city. He entered the employ of Simmons-Boardman in 1889. He was made secretary of the company in 1898, vice-president and treasurer in 1903 and president in 1911. He was also chairman of the board of the American Saw Mill Machinery Company and the Corley Manufacturing Company. During the late war, he served in the construction division of the United States Army. He was a member of the A.S.M.E., A.S.C.E and the Engineers Club of New York.

EDGAR R. HAWLE, president of the Hawley-Richardson-Williams Company, Salt Lake City, Utah, died in that city Sept. 14 of acute pneumonia after an illness of about a week. He was well known in the West as a heating and ventilation engineer. As a consulting engineer, he designed the heating and ventilating systems for a number of large buildings, including the state capitols of both Utah and Idaho.

Personals

DR. H. H. LOWRY has been appointed by the American Chemical Society as its representative on the Sectional Committee on Classification of Coal of the American Standards Assocation, to succeed Professor SAMUEL W. PARR, who died last May. Dr. Lowry is connected with the Coal Research Laboratory of the Carnegie Institute of Technology in Pittsburgh.

W. A. BECHTEL, SR., formerly vice-president of the Six Companies, Inc., which holds the contract for the construction of Hoover Dam, has been made president of that company, succeeding the late W. H. WATTIS. Mr. Bechtel is president of the W. A. Bechtel Company, one of the member organizations which comprise the Six Companies, Inc. E. O. WATTIS, brother of the late president, was elected to succeed Mr. Bechtel as first vice-president, and H. W. MORRISON, vice-president and general manager of the Morrison-Knudson Company of Boise, Idaho, was chosen to succeed Mr. Wattis as second vice-president.

DAVID ZUEGE, of the Sivyer Steel Casting Company, has been appointed by the Steel Founders' Society of America as its representative on the American Society for Testing Materials Committee on Specifications for Valves, Fittings, Piping and Flanges for High-Temperature Service. FRED GROTTS, Hubbard Steel Foundry, and WILLIAM J. CORBETT, Fort Pitt Steel Casting Company, have been appointed to represent the Steel Founders' Society on other A.S.T.M. committees.

C. D. REASOR has been appointed district manager of the electric and gas properties of the Western Power, Light & Telephone Company in Oklahoma and Kansas. He succeeds FRANK M. GUILD, who for some time has been district manager in Kansas. Mr. Reasor's headquarters will be in Harper, Kan., where he will have charge of all field activities of the company's electric and gas divisions.

DR. L. V. REDMAN, vice-president and director of research of the Bakelite Corporation, has been awarded the Grasselli Medal, industry's annual tribute to distinction in applied chemistry, it is announced by the American Section of the Society of Chemical Industry, a British organization. The selection of Dr. Redman, who is president-elect of the American Chemical Society, was based upon industrial studies, the results of which were embodied in a paper on "Cost of Research and its Apportionment" read before a joint meeting on Dec. 9, 1927, of the American Section of the Society of Chemical Industry with the New York Section of the American Chemical Society, the Societe de Chimie Industrielle and American Electrochemical Society.

Business Notes

WORTHINGTON PUMP & MACHINERY CORPORATION, Harrison, N. J., announces that at a recent meeting of its board of directors, LaMonte J. Belnap, president of the company, was elected chairman of the executive committee. Harry C. Beaver, who has been associated with Mr. Belnap in various enterprises for the past 25 years, was elected president to succeed him. As chairman of the executive committee, Mr. Belnap maintains his active part in directing the manufacturing, sales and financial activities of the Worthington corporation, it is stated.

PITTSBURGH STEEL PRODUCTS COMPANY, a division of the Pittsburgh Steel Company, Pittsburgh, Pa., announces an increase in its facilities for manufacturing seamless steel tubing through the purchase of a complete new unit of the "push-bench" type from the Aetna Standard Engineering Company. Hitherto unused in this country for making steel tubes, this unit operates on the same basic principle employed in manufacturing steel shell forgings during the late war, and produces tubing in longer lengths with better finish and a higher degree of accuracy on the diameter and wall. Its principal feature lies in making possible the production of very small-diameter tubes by the hot-rolled reducing process, which formerly could only be made by the more expensive method of cold drawing.

CATERPILLAR TRACTOR COMPANY, Peoria, Ill., announces its entry into the industrial engine business. On Sept. 21 W. H. Gardner, advertising manager of the company, was promoted to take charge of a newly created specialty sales division which will offer to other manufacturers of equipment the company's engines, both gas and diesel, and certain sub-assemblies hitherto used only on Caterpillar machinery.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., announces the appointment of Roscoe Seybold as comptroller of the company. Mr. Seybold, who advances to the position of comptroller from the post of assistant to the president, has been continuously in the service of the company for 24 years.

GARDNER-DENVER COMPANY, Quincy, Ill., announces the appointment of the Interstate Machinery & Supply Company, Omaha, Neb., as sales agent for its products in Omaha and vicinity.

L. H. GILMER COMPANY, Philadelphia, Pa., announces the promotion of Charles H. Bauer to the position of general sales manager of the company. For the past six years Mr. Bauer has been sales manager of the company's automotive division. In his new position he will have charge of industrial sales as well.

How's Business?

THE LAST QUARTER opens without significant sign of autumn acceleration or promising prospect of early improvement in the business picture in any other essential respect, according to *The Business Week*, Oct. 7. Current indicators give no evidence that business is going to break through the rock bottom resistance level which bare replacement demands have established since last December, in spite of the pressure of accumulating credit difficulties and disappointing performance in security and commodity markets. Our index still holds above the 70 per cent line, despite persistent weakness in most components, and there is some reassurance in the super-seasonal strength of building projects.

Production of electricity by public utilities for the week ended Sept. 26 was 1,660,204,000 kw.-hr., a decrease of 3.2 per cent below the output for the corresponding period of 1930, according to N.E.L.A. figures.

Trade Catalogs

WATER TREATMENT—A full line of water-testing equipment for laboratory and power plant use is described and illustrated in a new publication of the National Aluminate Corporation, 6216 West 66th Pl., Chicago, Ill. Helpful instructions for making various kinds of water tests are also included.

PUMPS—Bulletin No. 314, just issued by the Byron Jackson Company, Berkeley, Calif., presents a comprehensive description of the design and construction features of centrifugal oil-refinery pumps. Numerous charts and illustrations supplement the text.

DRYERS—Eleven styles of dryers are described in the latest illustrated bulletin (No. 69) of the C. O. Bartlett & Snow Company, 6200 Harvard Ave., Cleveland, Ohio. In addition, it contains much useful data pertaining to the dryer field in general.

INSULATION—The many applications of cork insulation and cork products are fully described in a new illustrated publication of the Cork Insulation Company, 154 Nassau St., New York City. Among the subjects covered are cork pipe covering, machinery isolation, acoustical corkboard and marine installations.

BLOWERS AND PUMPS—The Roots-Connersville-Wilbraham Division of the International-Stacey Corporation, Connersville, Ind., has just issued four new bulletins covering standard and heavy-duty blowers and gas pumps. These bulletins supersede all former publications on these products issued separately in the past by the P. H. & F. M. Roots Company, Connersville Blower Company and Wilbraham-Green Blower Company.

RESISTANCE TESTERS—A full description of the "Bridge-Meg" and Varley Loop "Bridge-Meg" resistance testers is contained in a new illustrated catalog (No. 1290) issued by the James G. Biddle Company, 1211-13 Arch St., Philadelphia, Pa.

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Fuel Prices

FUEL OIL

Boston—Sept. 28, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.87c. per gal.; 28@32 deg., 4.83c. per gal.

New York—(Oct. 1) Industrial use, f.o.b. harbor, tank cars or boats, per barrel of 42 gal.:

Bunker C, $0.70; Diesel, $1.40.

Tank-wagon delivery, per gal.:

No. 5 (18@20 deg.), $0.04½; No. 6 (14@16 deg.), $0.03½.

Philadelphia — Sept. 28, tank-wagon delivery, No. 3 industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—Sept. 25, f.o.b. local refinery, fuel oil, 36@40 deg., 2.5c.@2.75c. per gal.

Cincinnati—Sept. 29, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Sept. 22, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 22.5c. per bbl.; 22@24 deg., 25c. per bbl.; 24@26 deg., 27.5c. per bbl.; 26@28 deg., 32.5c. per bbl.; 28@30 deg., 37.5c. per bbl.

St. Louis—Sept. 22, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.02 per bbl., or 42 gal.; 26@28 deg., $1.095 per bbl.; 28@30 deg., $1.195 per bbl.; 30@32 deg., $1.245 per bbl.; 32@36 deg., gas oil, 2.776c. per gal.; 38@40 deg., distillate, 3.151c. per gal.

Dallas—Sept. 26, f.o.b. local refinery, 24@26 deg., 70c. per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol..	New York.	$1.65@$1.80
Pool 10, h. gr. low-vol..	New York	1.50@ 1.65
Pool 11, low-vol.....	New York.	1.40@ 1.50
Smokeless, mine-run...	Chicago...	1.75@ 2.00
Smokeless, slack.....	Chicago...	.40@ 1.00
Harlan, Ky., slack.....	Chicago...	.60@ .90
Franklin, Ill., mine-run	Chicago...	2.15
Franklin, Ill., screen....	Chicago...	1.10@ 1.60
Ind. 5th Vein, m.-r.....	Chicago...	1.20@ 1.75
Standard Ill., mine-run.	St. Louis...	1.25@ 1.40
W. Ky., mine-run.....	Louisville..	.85@ 1.25
W. Ky., slack.....	Louisville..	.15@ .40
Pittsburgh, mine-run...	Pittsburgh.	1.25@ 1.35
Smokeless, mine-run...	Cincinnati.	1.75@ 2.00
Smokeless, slack.....	Cincinnati.	.35@ .60
Kanawha, mine-run....	Cincinnati.	1.00@ 1.25
Kanawha, nut-slack....	Cincinnati.	.35@ .60
Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat.....	New York.	$3.25
Barley.....	New York.	.90@ 1.40

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ala., Montgomery—Constructing Quartermaster, M. A. McFadden, awarded contract for the construction of a boiler plant, distribution system and steam conduit to Louis Gertner, 8233 Harper Ave., Chicago, Ill., 300,000 gal. tank on 100 ft. tower to Chicago Bridge & Iron Works, 37 West Van Brunt St., Chicago, Ill., and radio building to Algernon Blair, Montgomery, Ala. Estimated total cost $63,785.

Ariz., Florence—Randolph Irrigation District, voted $624,000 bonds for irrigation works to supply water to 9,600 acres, including thirty-four complete pumping plants and wells. Scott Engineering Co., Phoenix, Ariz., is engineer.

Ariz., Safford—Arizona General Utilities Co., c/o S. S. Cobb, Mgr., plans addition to power plant to increase present capacity 625 hp. Estimated cost $70,000. Will require new machinery.

Ark., Benton—Farm Colony, State Hospital for Nervous Diseases, c/o Arkansas Construction Commission, T. Davis, Secy., 207 Marion Hotel, Little Rock, will receive bids until Oct. 22, for a boiler house, smoke stack, underground steam and hot water distribution system and construction and installation of boilers and boiler room appurtenances here. Mann, Wanger & Kling, 1316 Donaghey Bldg., Little Rock, are engineers.

Ark., Pine Bluff—Arkansas Power & Light Co., Harvey Couch, Pres., plans the construction of new transmission lines, also sub-station improvements, etc. Estimated cost $375,000. Work will be done by owner's forces.

Calif., Los Angeles — City and other communities, voted $220,000,000 bonds to finance construction of 252 mi. aqueduct along Parker route on Colorado River to include storage reservoir, pumping plant, diversion dam, etc., for Metropolitan Water District. F. E. Weymouth is chief engineer.

Calif., Los Angeles — University of California, awarded general contract for the construction of a men's gymnasium and women's physical education building to Bannister-Field Co., 4101 Goodwin Ave., also heating and ventilation systems, boiler plant, etc., to Thomas Haverty Co., 8th and Maple Sts. Estimated total cost $1,000,000.

Conn., Willimantic—Windham County Memorial Hospital, G. E. Taylor, Chn. Bldg. Comn., awarded contract for the construction of a hospital nurse's home, power plant and laundry at West Main and Mansfield Sts., to H. Wales Lines Co., 134 State St., Meriden. $500,000.

Ind., Crown Point—City postponed taking of bids for two 100 kw. Diesel driven motors and two 250 g.p.m. deep well pumps for proposed improvements to light plant. Estimated cost $33,000.

Ind., Fort Wayne—Board of Public Works, will receive bids until Nov. 3 for the construction of a filtration plant and pumping station 24 m.g.p.d. capacity in connection with waterworks. Hoad, Decker, Shoecraft & Drury, Ann Arbor, Mich., are consulting engineers.

Ia., Fairfield—City, plans an election Oct. 13 to vote bonds for the construction of a municipal light and power plant.

Ia., Sioux City—Sioux City Service Co., J. E. Everson, Supt., Big Sioux Power Plant, will build a 40 x 70 ft. addition to power plant. Work will be done by local labor.

Kan., Fort Leavenworth—U. S. Army, Capt. L. B. Gerow, Constructing Quartermaster, will receive bids until Oct. 8 for the construction of double hangar with annexes and boiler house annex. $83,700. Private plans.

Mich., Detroit—Detroit Edison Co., 2000 Second Blvd., completed plans for addition to steam power plant at Connors Creek Station. Estimated cost $1 000 000.

Mich., Wyandotte—Municipal Service Commission, will soon award contract for the construction of a power plant including steam operated electric power generating equipment, two 600 hp. boilers, coal handling equipment, etc., at Van Alstyne Blvd. and Vinewood Ave. Estimated cost $300,000. Froelich & Emery, Second National Bank Bldg., Toledo, are engineers.

Minn., Duluth—Duluth Steam Corp. will soon receive bids for the construction of an 8 story, 93 x 140 ft. generating plant at Lake Ave. and Commerce St. for central heating system. Estimated total cost $1,500,000. Contracts awarded for underground construction, mains, manufacture and installation of boilers and fueling equipment.

Minn., Kenyon—City received lowest bid for the construction of a power house from Nietge Construction Co., Mankato, electrical distribution system from Minneapolis Electric & Construction Co., 80 South 12th St., Minneapolis, and Diesel engines and equipment from Fairbanks, Morse & Co., 417 South 4th St., Minneapolis. Estimated total cost $92,698.

Missouri and Oklahoma—Stanolind Pipe Line Co., Philcade Bldg., Tulsa, Okla., awarded contract for 36 x 66 ft. additions to pumping stations at Carrollton, Freeman, Marceline, Odessa, Mo., and Hominy, and Hulan, Okla., to W. R. Grimshaw Construction Co., Kennedy Bldg., Tulsa, Okla. Estimated total cost $90,000.

Mo., St. Louis—Board of Public Service, will receive bids until Oct. 27 for the construction of a 72 x 194 ft. market building, including boiler room, open and shelter platforms, etc., at 13th, Biddle and O'Fallon Sts. $94,637. A. Osburg, 301 City Hall, is architect. L. R. Bowen, 301 City Hall, is engineer.

O., Cleveland—City, D. R. Morgan, Mgr., plans an election Nov. 3 to vote $2,500,000 bonds for additions and extensions to electric light plant, including 15,000 kw. unit to replace 5,000 kw. unit; also 20,000 kw. unit or 20,000 kw. unit and three boilers or one 25,000 kw. turbo-generator on East 53rd St. L. A. Quayle, City Hall, is engineer.

O., Lima—City will receive bids until Oct. 14 for the construction of a 4 story hospital, nurse's home, power plant and laundry. Estimated cost $600,000. T. D. McLaughlin & Associates, Dominion Bldg., are architects.

Okla., Muskogee—Community Ice & Produce Co., E. L. Ashcroft, Sulphur Springs, Tex., acquired a site and plans the construction of a 30 ton ice and cold storage plant at 5th and Denison Sts., here. Estimated cost $50,000.

Okla., Muskogee—George E. Wells, Inc., Little Rock, Ark., acquired a site and plans the construction of a 60 ton ice and cold storage plant at Cherokee and Fond du Lac Sts., here. Estimated cost $125,000.

Okla., Pryor—City plans an election Oct. 8 to vote $75,000 bonds for the construction of a new electric light plant. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Pa., Fort City—City, A. B. Mahoney, Clk., City Hall, awarded contract for furnishing and insfalling a 500 kw. Diesel oil engine generator to Nordberg Mfg. Co., East Oklahoma and Chase Ave., Milwaukee, Wis., cooling tower and closed type cooling system for 1,500 brake hp. and Diesel oil and overload storage tank and auxiliaries to A. F. Pritchard Co., 528 Dwight Bldg., Kansas City, Mo., and one switchboard and switching equipment with wiring, conduit and auxiliaries to Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Estimated total cost $53,256.

R. I., Howard—Public Welfare Commission, awarded contract for furnishing and installing a 500 hp. Cross Drum water tube boiler to Wickes Boiler Co., Saginaw, Mich., brick setting to Charles McCormick, Providence, multiple retort stoker to Combustion Engineering Corp., 80 Federal St., Boston, Mass., and cinder trap with butterfly damper at central power plant to Green Fuel Economizer Co., 201 Devonshire St., Boston, Mass.

Tex., Crystal City—City postponed $128,000 bond election Sept. 26 for the construction of a municipal electric light and power plant.

Tex., Mineola—City, c/o John Russel, Mayor, awarded contract for improvements to sanitary sewerage system including pumping station, disposal plant, etc., to Panhandle Construction Co., Lubbock.

Utah—Murray—City will soon award contract for the construction of an intake and diversion dam and power plant. $18,000. Bledsecker & Bledsecker, Murray, are engineers.

Ont., Pembroke—Town plans the construction of a waterworks filtration plant including filters, pumps, etc. Estimated cost $100,000. J. P. Howe, Town Hall, is engineer.

Equipment Wanted

Air Compressor, Electric Blower, Transformers, Etc.—Washington, D. C.—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Oct. 12 for air compressor, electric blower, 5 hp. motor, transformers, switches, etc.

Boilers, Pumps, Etc.—Grafton, N. D.—E. G. Wanner, Exec. Secy., Board of Administration, will receive bids until Oct. 20 for boilers, firing equipment, feed pumps, forced fan draft units, feed water heaters, generating unit, etc. for power plant at Institution for Feeble Minded here.

Generator Unit—Winterset, Ia.—G. B. DeVault, Clk., will receive bids until Oct. 19 for one 500 kw. Diesel oil engine generator unit.

Power Plant Equipment—Willmar, Minn.—H. W. Austin, Comr. of Purchases, State Capitol Bldg., St. Paul, will receive bids until Oct. 16 for power plant equipment, including a 200 kw. engine generator set at Willmar State asylum.

Stokers, Generating Equipment, Etc.—Slippery Rock, Pa.—Slippery Rock State Teachers College, J. Linwood, Elsenberg, Pres., plans to purchase mechanically operated stokers under two largest boilers, smoke stacks and electrical generating equipment in connection with proposed power plant improvements.

Transformers—Cleveland, O.—City will receive bids until Oct. 9 for constant current regulating transformers.

Industrial Projects

Calif., Bay Point—Armstrong Cork Co., Lancaster, Pa., has completed plans for a new manufacturing plant here. Estimated cost $1,000,000. Maturity indefinite.

Calif., Southgate—Firestone Tire & Rubber Co., Manchester Ave. and Alameda St., Los Angeles, plans the construction of a battery factory here. Estimated cost to exceed $150,000.

Ill., Chicago—Central Mfg. District, 38 South Dearborn St., will build a butter plant and refrigeration warehouse. Estimated cost to exceed $40,000. Work will be done by separate contracts. Great Atlantic & Pacific Tea Co., 420 Lexington Ave., New York, N. Y., lessees, will transfer equipment from present plant to new building.

Ind., Vincennes—Central Fibre Co., awarded contract for addition to factory and power plant on Scott St. to Voight & Son, Louisville, Ky. Estimated cost $40,000. Contract for power plant equipment awarded.

Me., Dixfield—Berst-Foster-Dixfield Co., F. W. Smith, Mgr., awarded contract for a 3 story, 105 x 200 ft. addition to factory, to J. H. Kerr, Prospect St., Rumford. Estimated cost $40,000.

Mass., Salem—Donnell & Mudge, Canal St. and Ocean Ave., manufacturers of asbestos shingles, awarded contract for a 2 story factory to Pitman & Brown Co., 11 Washington St.

Mich., Ypsilanti—A. Kahn, 1000 Marquette Bldg., Detroit, Archt., will receive bids about Oct. 10 for the construction of a 1 story, 160 x 350 ft. automobile factory here for Ford Motor Co., Dearborn, Mich. Estimated cost $100,000.

Mo., Windsor—International Shoe Co., W. H. Moulton, Pres., 1501 Washington Ave., St. Louis, will build a shoe factory here. Estimated cost $80,000. Work will be done by local labor.

N. J., Allwood—American Colortype Co., 207 West 25th St., New York, N. Y., awarded contract for alterations to plant to M. C. Tredennick, 25 West 45th St., New York. Estimated cost $40,000.

N. Y., Richmond Hill—Anheuser Busch, Inc., 979 Brook Ave., New York, plans alterations to ice cream manufacturing plant and garage at 104th St. and Atlantic and 94th Aves., here. Estimated cost $40,000. J. E. Ross, 23 West 43rd St., is architect.

N. Y., Ridgewood—Muller Paper Goods Co., Prospect Ave. and Linden St., plans addition and alterations to plant, 1 and 3 story, 99 x 100 ft. Estimated cost $75,000. H. Brucker, 2424 Myrtle Ave., is architect.

Texas—Humble Oil & Refining Co., Humble Bldg., Houston, is having surveys made for the construction of three refineries at Pitner Junction, Kilgore and Gladewater. Estimated total cost $1,000,000. Private plans.

Wis., Kaukauna — Thilmary Pulp & Paper Co., M. A. Werthheimer, Pres., plans the construction of a 2 story pulp and paper plant, warehouse and office building. Estimated cost $40,000. Architect not selected.